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For and on behalf of RWS Group Ltd
The 27th day of February 2009

FEDERAL REPUBLIC OF GERMANY



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Priority Certificate for the filing of a Patent Application

File Reference: 103 53 328.1

Filing date: 14 November 2003

Applicant/Proprietor: BASF Aktiengesellschaft, 67056 Ludwigshafen/DE

Title: Use of naphthalene-1,8-dicarboxylic monoimides

IPC: C 07 D, C 09 K, C 08 K

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Description

The present invention relates to the use of naphthalene-1,8-dicarboxylic monoimides for protecting orgaryl material against the damaging effects of light.

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Living and inanimate orgaryl material, such as human or animal skin, human or animal hair, foods, perfumes, cosmetics, plastics, polymer dispersions, paints, photographic emulsions, photographic layers, etc., is frequently sensitive to the damaging effects of light, and particularly to the ultraviolet (UV) radiation fraction which is present in day-
10 light. The damage may be due to the UVA fraction of the UV radiation, i.e., the region from above 320 to 400 nm, the UVB fraction of UV radiation, i.e. the region from 280 to 320 nm, and the even shorter-wave fractions of UV radiation. There is therefore a substantial and ongoing demand for new substances which provide effective protection against such damaging effects. In this application the substances employed are in-
15 creasingly having to meet a complex profile of requirements adapted to the specific nature of the organic material to be protected and the circumstances under which protection is required.

Prior art

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It is known that the mecharyl, chemical and/or esthetic properties of orgaryl material, particularly of plastics, may be impaired under the effect of light. This impairment is normally manifested as yellowing, discoloration, cracking or embrittlement in the material. One important field of use for light stabilizers is therefore the protection of plastics.
25 Plastic containers and plastic films find widespread use as packaging materials, for example. For reasons of esthetics, plastics featuring high light transmission in the visible wavelength range from 400 to 750 nm are increasingly gaining importance as packaging materials. See-through plastics with or without slight coloration, however, are generally transparent to the UV fractions of daylight, with the consequence that,
30 under light, both the packaging material and the packaged products suffer aging. Depending on the specific packaged contents, the adverse alteration to the contents may be manifested, for example, in a change in appearance, such as yellowing and discoloration, in a change in taste and/or odor, and/or in the breakdown of ingredients. In the case of foods, perfumes, and cosmetics, the shelf life and keeping properties may be
35 sharply reduced. The stabilizers that are added to packaging plastic ought therefore to provide satisfactory protection both to the plastic itself and to the packaged product in respect of light-induced aging processes. Plastics are also in widespread use in combination with glass in composite materials which are transparent in the visible wavelength range. Composite systems of this kind find use in automotive glass panes, for example.
40 Automobile glass panes of this kind are increasingly being required to absorb radiation in the wavelength range below 400 nm, in order to protect the interior of the auto and its occupants against UV radiation, for example.

GB 1,003,083 describes 4-alkoxynaphthalene-1,8-dicarboxylic monoimides and their
45 use as optical brighteners for textiles. The textiles may consist of natural or synthetic

fibers, including polyamides, polyesters, polyurethanes, polyvinyl chloride, polyvinylidene chloride, polyacrylonitrile or polyvinyl alcohols.

5 EP 0682145 describes a method of improving the sun protection factor in textiles, wherein the textile fiber is treated with a composition comprising at least one optical brightener which absorbs in the wavelength range of 280 – 400 nm. Alongside a host of further compounds, suitable optical brighteners specified include (by way of a formula), naphthalene-1,8-dicarboxylic monoimides that carry in position(s) 4 and/or 5 a C₁-C₄ alkoxy, SO₃M (where definitions of M include H, Na, K, Ca, Mg, ammonium or mono-,
10 di-, tri- or tetra-C₁-C₄-alkylammonium) or NHCO-C₁-C₄ alkyl group. The only specific 4-substituted compound disclosed is the 4-methoxy compound. There are no working examples for this class of compound.

15 EP 0263705 describes the use of naphthalenetetracarboxylic acid or its derivatives as light stabilizers in thermoplastic polyester resin compositions, in which additional components that can be used include naphthalene monoimides. The imide group of the monoimides can be bonded at the 1,8, 2,3 or 3,4 positions of the naphthalene ring. The naphthalene ring is unsubstituted or can carry up to 6 substituents, selected from halo, hydroxyl, amino, nitro, cyano, sulfonic acid or metal salts thereof, optionally substituted
20 alkyl, optionally substituted alkenyl, optionally substituted aralkyl, and optionally substituted alkylaralkyl. Preferably the naphthalene ring of the naphthalene monoimides does not carry any substituents.

EP 0335595 describes thermoplastic polyester compositions comprising as UV absorbers a diimide compound plus, if desired, a naphthalene monoimide. The imide group of the monoimide can be bonded at the 1,2, 1,8 or 2,3 positions of the naphthalene ring. The naphthalene ring may carry up to 6 substituents, selected from halo, carboxyl or an ester thereof, hydroxyl, -O-C(=O)CH₃, amino, nitro, cyano, sulfonic acid or a metal salt thereof, optionally substituted alkoxy, optionally substituted aliphatic
25 groups, and optionally substituted aromatic groups.

JP1024852 describes the use of substituted or unsubstituted naphthalenedicarboxylic and -tetracarboxylic acids or their esters, imides, and anhydrides as light stabilizers for polyamide resins. The polyamide resins can be used as packaging material for foods.
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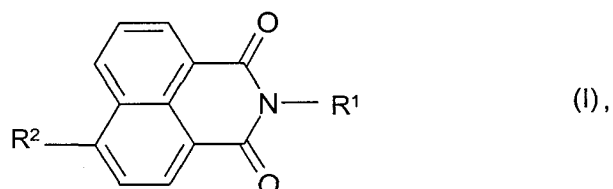
JP-7247978 describes brightener compositions for synthetic fibers, comprising a mixture of 4-substituted naphthalene-1,8-dicarboxylic monoimides and, if desired, alkyl-naphthalenesulfonates. The mixture comprises naphthalenecarboxylic monoimides in which the substituent in position 4 is a lower alkoxy or unsubstituted phenoxy or benzyloxy group and compounds in which the substituent in position 4 is an alkylthio, phenylthio or benzylthio group. The imide nitrogen atom can in each case be substituted by a hydrogen atom or by an alkyl or hydroxyl group. A significant disadvantage of the lower-alkoxy-substituted and/or unsubstituted-phenoxy-substituted naphthalene-1,8-dicarboxylic monoimides described is their low compatibility with plastics.
40
45

The prior art light stabilizers have a series of disadvantages. One substantial disadvantage is the period of the protective effect, which is often too short, since the known light stabilizers often have an inadequate UV stability. Another disadvantage is that many known light stabilizers have a clearly perceptible intrinsic color in the visible wavelength range, with the consequence that a plastic stabilized with these light stabilizers appears to have a pale yellow coloration. Furthermore, many light stabilizers are unable to filter out the longwave fraction of the UVA radiation. Many light stabilizers exhibit low solubility in the application medium. The resulting crystallization of the light stabilizer may make the polymer opaque. Further disadvantages are the frequently poor synthetic obtainability of the light stabilizers, their inadequate formulating properties, their low sublimation resistance and/or their low migration fastness. There is therefore still a need for stabilizers and stabilizer compositions which have improved performance properties and/or are easier to prepare.

Statement of the object

It is an object of the present invention, therefore, to provide stabilizers which are suitable as UV absorbers for protecting organic material such as plastics, polymer dispersions, paints, photographic emulsions, photographic layers, human or animal skin, human or animal hair, foods, etc. for a relatively long period of time. The stabilizers should preferably absorb with high extinction in the UVA region, and particularly also in the longwave UVA region above 360 nm, ought to be photostable and/or thermally stable, and ought to have little or no intrinsic color in the visible wavelength range.

Surprisingly it has now been found that the use of naphthalene-1,8-dicarboxylic monoimides of the formula I



in which

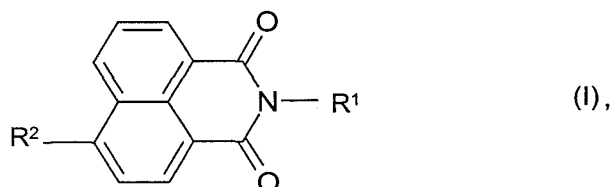
R^1 is hydrogen, alkyl, alkenyl, cycloalkyl, cycloalkenyl, heterocycloalkyl, aryl or heteroaryl and

R^2 is a radical containing at least one π electron system containing a carbon atom and at least one further atom selected from carbon, oxygen, and nitrogen, with the proviso that the radical contains at least one atom other than carbon

protects organic material against the damaging effects of light.

The present invention accordingly provides for the use of naphthalene-1,8-dicarboxylic monoimides of the formula I for protecting organic material against the damaging effects of light.

5 The present invention also provides compounds of the formula I



where

- 10 R^1 is hydrogen, alkyl, alkenyl, cycloalkyl, cycloalkenyl, heterocycloalkyl, aryl or heteroaryl, preferably C_1 - C_{12} alkyl, C_5 - C_8 cycloalkyl or phenyl, the two last-mentioned radicals each being unsubstituted or carrying one, two, three, four or five C_1 - C_4 alkyl groups, and
- R^2 is cyano, $-C(O)NR^5R^{5a}$ or phenoxy which carries one, two, three, four or five C_1 - C_{12} alkyl groups; and
- 15 R^5 and R^{5a} are each independently of one another hydrogen, C_1 - C_{18} alkyl, aryl or heteroaryl, aryl and heteroaryl each being unsubstituted or carrying one or more substituents selected preferably from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, hydroxyl, carboxyl, and cyano.
- 20 For the purpose of elucidating the present invention the expression "alkyl" embraces straight-chain and branched alkyl. Alkyl is preferably straight-chain or branched C_1 - C_{30} alkyl, particularly C_1 - C_{20} alkyl, and especially C_1 - C_{12} alkyl. Examples of alkyl groups are, in particular, methyl, ethyl, propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl, n-pentyl, 2-pentyl, 2-methylbutyl, 3-methylbutyl, 1,2-dimethylpropyl, 1,1-dimethylpropyl,
- 25 2,2-dimethylpropyl, 1-ethylpropyl, n-hexyl, 2-hexyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 2,3-dimethylbutyl, 1,1-dimethylbutyl, 2,2-dimethylbutyl, 3,3-dimethylbutyl, 1,1,2-trimethylpropyl, 1,2,2-trimethylpropyl, 1-ethylbutyl, 2-ethylbutyl, 1-ethyl-2-methylpropyl, n-heptyl, 2-heptyl, 3-heptyl, 2-ethylpentyl, 1-propylbutyl, n-octyl, 2-ethylhexyl, 2-propylheptyl, 1,1,3,3-tetramethylbutyl,
- 30 nonyl, decyl, n-undecyl, n-dodecyl, n-tridecyl, iso-tridecyl, n-tetradecyl, n-hexadecyl, n-octadecyl and n-eicosyl.

Alkyl also embraces an alkyl whose carbon chain can be interrupted by one or more nonadjacent groups selected from $-O-$, $-S-$, $-NR^3-$, $-CO-$ and/or $-SO_2-$; i.e., the termini of

35 the alkyl group are formed by carbon atoms.

The above remarks apply equally to alkoxy and to alkylamino.

40 Alkenyl refers in the sense of the present invention to straight-chain and branched alkenyl groups, which depending on chain length may carry one or more double bonds. They are preferably C_2 - C_{20} , especially C_2 - C_{10} , alkenyl groups, such as vinyl, allyl or

methallyl. "Alkenyl" also embraces substituted alkenyl groups, which can carry, for example, 1, 2, 3, 4 or 5 substituents. Examples of suitable substituents include cycloalkyl, heterocycloalkyl, aryl, heteroaryl, nitro, cyano, halo, amino, and mono- and di(C₁-C₂₀ alkyl)amino.

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Cycloalkyl for the purposes of the present invention embraces both substituted and unsubstituted cycloalkyl groups, preferably C₃-C₈ cycloalkyl groups such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl or cyclooctyl, and especially C₅-C₈ cycloalkyl. When substituted the cycloalkyl groups may carry one or more – for example, one, two, three, four or five – C₁-C₆ alkyl groups.

10

C₅-C₈ cycloalkyl, which is unsubstituted or may carry one or more C₁-C₆ alkyl groups, is, for example, cyclopentyl, 2- and 3-methylcyclopentyl, 2- and 3-ethylcyclopentyl, cyclohexyl, 2-, 3-, and 4-methylcyclohexyl, 2-, 3-, and 4-ethylcyclohexyl, 3- and 4-propylcyclohexyl, 3- and 4-isopropylcyclohexyl, 3- and 4-butylcyclohexyl, 3- and 4-sec-butylcyclohexyl, 3- and 4-tert-butylcyclohexyl, cycloheptyl, 2-, 3-, and 4-methylcycloheptyl, 2-, 3-, and 4-ethylcycloheptyl, 3- and 4-propylcycloheptyl, 3- and 4-isopropylcycloheptyl, 3- and 4-butylcycloheptyl, 3- and 4-sec-butylcycloheptyl, 3- and 4-tert-butylcycloheptyl, cyclooctyl, 2-, 3-, 4-, and 5-methylcyclooctyl, 2-, 3-, 4- and 5-ethylcyclooctyl, and 3-, 4-, and 5-propylcyclooctyl.

20

Aryl for the purposes of the present invention embraces monocyclic or polycyclic aromatic hydrocarbon radicals which may be unsubstituted or substituted. Aryl is preferably phenyl, tolyl, xylol, mesityl, duryl, naphthyl, fluorenyl, anthracenyl, phenanthrenyl or naphthacenyl, more preferably phenyl or naphthyl, it being possible for these aryl groups when substituted to carry generally 1, 2, 3, 4 or 5, preferably 1, 2 or 3, substituents selected from C₁-C₁₈ alkyl, C₁-C₆ alkoxy, cyano, CONR^{4a}, CO₂R⁴, arylazo, and heteroarylo, with arylazo and heteroarylo themselves being unsubstituted or carrying one or more radicals selected independently of one another from C₁-C₁₈ alkyl, C₁-C₆ alkoxy, and cyano.

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Aryl, unsubstituted or carrying one or more radicals selected independently of one another from C₁-C₁₈ alkyl, C₁-C₆ alkoxy, and cyano, is, for example, 2-, 3-, and 4-methylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-dimethylphenyl, 2,4,6-trimethylphenyl, 2-, 3-, and 4-ethylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-diethylphenyl, 2,4,6-triethylphenyl, 2-, 3-, and 4-propylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-dipropylphenyl, 2,4,6-tripropylphenyl, 2-, 3-, and 4-isopropylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-diisopropylphenyl, 2,4,6-triisopropylphenyl, 2-, 3-, and 4-butylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-dibutylphenyl, 2,4,6-tributylphenyl, 2-, 3-, and 4-isobutylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-diisobutylphenyl, 2,4,6-triisobutylphenyl, 2-, 3-, and 4-sec-butylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-di-sec-butylphenyl, 2,4,6-tri-sec-butylphenyl, 2-, 3-, and 4-tert-butylphenyl, 2,4-, 2,5-, 3,5-, and 2,6-di-tert-butylphenyl and 2,4,6-tri-tert-butylphenyl; 2-, 3-, and 4-methoxyphenyl, 2,4-, 2,5-, 3,5-, and 2,6-dimethoxyphenyl, 2,4,6-trimethoxyphenyl, 2-, 3-, and 4-ethoxyphenyl, 2,4-, 2,5-, 3,5-, and 2,6-diethoxyphenyl, 2,4,6-triethoxyphenyl, 2-, 3-, and 4-propoxyphenyl, 2,4-, 2,5-, 3,5-, and 2,6-dipropoxyphenyl, 2-, 3-, and 4-

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isopropoxyphenyl, 2,4-, 2,5-, 3,5-, and 2,6-diisopropoxyphenyl, 2-, 3-, and 4-butoxyphenyl; and 2-, 3-, and 4-cyanophenyl.

5 Heterocycloalkyl for the purposes of the present invention embraces nonaromatic, unsaturated or fully saturated, cycloaliphatic groups having generally 5 to 8 ring atoms, preferably 5 or 6 ring atoms, in which 1, 2 or 3 of the ring carbon atoms are replaced by heteroatoms selected from oxygen, nitrogen, sulfur, and a group $-NR^3$, and being unsubstituted or substituted by one or more – for example, 1, 2, 3, 4, 5 or 6 - C_1 - C_6 alkyl groups. Examples that may be given of such heterocycloaliphatic groups include pyrrolidinyl, piperidinyl, 2,2,6,6-tetramethylpiperidinyl, imidazolidinyl, pyrazolidinyl, oxazolidinyl, morpholidinyl, thiazolidinyl, isothiazolidinyl, isoxazolidinyl, piperazinyl, tetrahydrothiophenyl, dihydrothien-2-yl, tetrahydrofuran-2-yl, dihydrofuran-2-yl, tetrahydro-
10 pyran-2-yl, 1,2-oxazolin-5-yl, 1,3-oxazolin-2-yl, and dioxanyl.

15 Heteroaryl for the purposes of the present invention embraces substituted or unsubstituted, heterocycloaromatic, monocyclic or polycyclic groups, preferably the groups pyridyl, quinolinyl, acridinyl, pyridazinyl, pyrimidinyl, pyrazinyl, pyrrolyl, imidazolyl, pyrazolyl, indolyl, purinyl, indazolyl, benzotriazolyl, 1,2,3-triazolyl, 1,3,4-triazolyl, and carbazolyl, which when substituted can carry generally 1, 2 or 3 substituents. The substituents are selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, hydroxyl, carboxyl, and cyano.
20

5- to 7-membered heterocycloalkyl or heteroaryl radicals bonded by a nitrogen atom and optionally containing further heteroatoms are, for example, pyrrole, pyrazole, imidazole, triazole, pyrrolidine, pyrazoline, pyrazolidine, imidazoline, imidazolidine, pyridine, pyridazine, pyrimidine, pyrazine, triazine, piperidine, piperazine, oxazole, isooxazole, thiazole, isothiazole, indole, quinoline, isoquinoline or quinaldine.
25

In accordance with the invention the radical R^2 includes at least one n electron system having a carbon atom and at least one further atom selected from carbon, oxygen, and nitrogen. It is understood in the context of the present invention to embrace π electron systems both with localized and with delocalized π bonds. The π electron systems with delocalized π bonds include aromatic compounds, heteroaromatic compounds, and polyenes. An n electron system is generally possible only in the case of polyatomic groups.
30

35 Examples of π electron systems made up of carbon atoms are groups having one or more $C=C$ double bonds such as in alkenyl, cycloalkenyl or aryl, and groups having at least one $C\equiv C$ triple bond such as in alkynyl or cycloalkynyl. Examples of groups with an n electron system having at least one carbon atom and at least one further atom selected from oxygen and nitrogen are corresponding heteroaryls, and the carbonyl group, for example, the keto group or aldehyde group, the carboxyl group, and also the carboxylate group, the ester group, the amide group, and the anhydride group, groups having a $C=N$ double bond such as in imines, and groups having a $C\equiv N$ triple bond as in nitriles. It will be appreciated that R^2 may contain two or more π electron systems
40 selected independently of one another from the aforementioned groups. Preferably R^2 contains only one n electron system.
45

The expression "in which R^2 is a radical which contains at least one n electron system having a carbon atom and at least one further atom selected from carbon, oxygen, and nitrogen, with the proviso that the radical contains at least one atom other than carbon" is understood in the context of the present invention to mean that R^2 has at least one non-carbon atom, i.e., at least one heteroatom -- one or two heteroatoms, for example. The heteroatom may be an oxygen, nitrogen or sulfur atom, for example. The heteroatom may in principle be in any position within R^2 . For example, the heteroatom may be part of the π electron system. The n electron system may also consist solely of carbon atoms, so that the heteroatom must be at a different position in R^2 . R^2 may be bound to the naphthalene-1,8-dicarboxylic monoimide skeleton by way of a carbon atom or by way of a heteroatom, an oxygen atom for example.

One first preferred embodiment of the present invention relates to the use of at least one compound I in which

R^1 is C_1 - C_{30} alkyl whose carbon chain may be interrupted by one or more nonadjacent groups selected from -O-, -S-, - NR^3 -, -CO- and/or - SO_2 -, and/or which is unsubstituted or substituted one or more times by identical or different radicals selected from cyano, amino, hydroxyl, carboxyl, aryl, heterocycloalkyl, and heteroaryl, with aryl, heterocycloalkyl, and heteroaryl groups being unsubstituted or carrying one or more substituents selected independently of one another from C_1 - C_{18} alkyl and C_1 - C_6 alkoxy; or
 R^1 is C_5 - C_8 cycloalkyl which is unsubstituted or carries one or more C_1 - C_6 alkyl groups; or
 R^1 is 5- to 8-membered heterocycloalkyl which is unsubstituted or carries one or more C_1 - C_6 alkyl groups; or
 R^1 is aryl or heteroaryl, with aryl or heteroaryl being unsubstituted or carrying one or more radicals selected independently of one another from C_1 - C_{18} alkyl, C_1 - C_6 alkoxy, cyano, $CONR^4R^{4a}$, CO_2R^4 , arylazo, and heteroarylazo, with arylazo and heteroarylazo in turn being unsubstituted or carrying one or more radicals selected independently of one another from C_1 - C_{18} alkyl, C_1 - C_6 alkoxy, and cyano;
 R^3 is hydrogen or C_1 - C_6 alkyl; and
 R^4 and R^{4a} each independently are hydrogen, C_1 - C_{18} alkyl, aryl or heteroaryl, with aryl and heteroaryl in each case being unsubstituted or carrying one or more substituents selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, hydroxyl, carboxyl and cyano.

Particular preference is given to compounds I wherein R^1 is C_1 - C_{12} alkyl, C_5 - C_8 cycloalkyl or phenyl, the two last-mentioned radicals each being unsubstituted or carrying one, two, three, four or five C_1 - C_4 alkyl groups. Especially preferred compounds I are those wherein R^1 is C_1 - C_{12} alkyl or C_5 - C_8 cycloalkyl, especially cyclohexyl, which is unsubstituted or carries a C_1 - C_4 alkyl group, or R^1 is phenyl which is unsubstituted or carries one, two or three C_1 - C_4 alkyl groups. If phenyl carries two or three C_1 - C_4 alkyl groups, then two of them are preferably attached in positions 2 and 6.

If R^1 is an alkyl radical having at least one heterocycloalkyl substituent or one heteroaryl substituent, the radical in question is preferably a 5- to 7-membered heterocycloalkyl which is attached to the alkyl radical via a nitrogen atom, or a 5- to 7-membered heteroaryl which is attached to the alkyl radical via a nitrogen atom.

5

R^1 is, for example, 2-ethylhexyl, cyclohexyl, 4-tert-butylcyclohexyl, phenyl, 2,6-diisopropylphenyl or 2,4,6-trimethylphenyl.

10 A characteristic feature of the compounds I is the radical R^2 with at least one n electron system and at least one heteroatom. The n electron system may contain one or more – for example, one or two – heteroatoms. In one preferred embodiment of the present invention the n electron system comprises at least one nitrogen and/or oxygen heteroatom. In that case the radical R^2 is preferably attached via a carbon atom of the π electron system to the naphthalene-1,8-dicarboxylic monoimide skeleton. The radical R^2
15 which characterizes the compound I is, in particular, cyano or $-C(O)NR^5R^{5a}$, where R^5 and R^{5a} are as defined above. Preferably R^5 and R^{5a} each independently of one another are hydrogen or C_1 - C_{18} alkyl, and in particular are each hydrogen.

20 Compounds I in which R^2 is cyano are referred to below sometimes as compounds I-A. Compounds I in which R^2 is $-C(O)NR^5R^{5a}$ where R^5 and R^{5a} are as defined above are referred to below sometimes as compounds I-B.

25 In a further preferred embodiment of the present invention the n electron system comprises only carbon atoms; i.e., the heteroatom is not a constituent of the π electron system. Preferably the n electron system is then attached via a heteroatom to the naphthalene-1,8-dicarboxylic monoimide skeleton. A particularly suitable heteroatom is oxygen. In that case the radical R^2 is preferably phenoxy which carries one, two, three, four or five substituents. Substituents of the phenoxy radical are preferably selected from C_1 - C_{12} alkyl, C_1 - C_{12} alkoxy, $-COOR^6$, $-SO_3R^6$, halo, hydroxyl, carboxyl, cyano,
30 $-CONR^5R^{5a}$, and $-NHCOR^5$, where R^5 , R^{5a} , and R^6 are as defined above. Particularly preferred alkyl substituents are C_1 - C_{10} alkyl radicals, especially C_3 - C_{10} alkyl radicals. In particular the substituents on the phenyl ring are selected from substituents containing only carbon atoms, so that the radical R^2 contains only 1 heteroatom. In a further, especially preferred embodiment of the present invention the phenoxy group carries in
35 position 4 a C_1 - C_{10} alkyl group, in particular C_3 - C_{10} alkyl group such as isopropyl, 1,1-dimethylpropyl (tert-pentyl) or 1,1,3,3-tetramethylbutyl (tert-octyl).

Compounds I in which R^2 is substituted phenoxy are referred below sometimes as compounds I-C.

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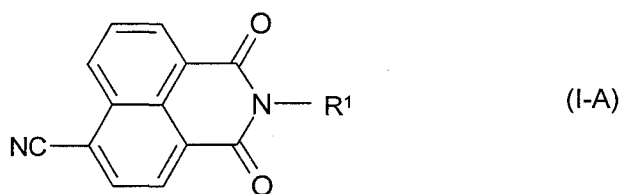
Especially preferred among the naphthalene-1,8-dicarboxylic monoimides I are those in which R^1 and R^2 in combination have the definitions indicated below:

R^1 is C_1 - C_{12} alkyl, especially C_1 - C_{10} alkyl, C_5 - C_8 cycloalkyl which is unsubstituted or carries a C_1 - C_4 alkyl group, especially cyclohexyl which is unsubstituted or carries a C_1 - C_4 alkyl group, or phenyl which is unsubstituted or carries one, two or
45 three C_1 - C_4 alkyl group(s), and

R^2 is cyano, $-C(O)NH_2$ or phenyloxy which carries a C_1 - C_{10} alkyl group, preferably a C_3 - C_{10} alkyl group.

Examples of suitable naphthalene-1,8-dicarboxylic monoimides I include 4-cyano-*N*-(cyclohexyl)naphthalene-1,8-dicarboximide, 4-cyano-*N*-(4-tert-butylcyclohexyl)naphthalene-1,8-dicarboximide, 4-cyano-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide, 4-cyano-*N*-(phenyl)naphthalene-1,8-dicarboximide, 4-cyano-*N*-(2,4,6-trimethylphenyl)naphthalene-1,8-dicarboximide, 4-aminocarbonyl-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide, *N*-(2,6-diisopropylphenyl)-4-(4-tert-octylphenoxy)naphthalene-1,8-dicarboximide, *N*-(2,6-diisopropylphenyl)-4-(4-isopropyl)naphthalene-1,8-dicarboximide, *N*-(2,6-diisopropylphenyl)-4-(4-tert-pentylphenoxy)naphthalene-1,8-dicarboximide, *N*-(phenyl)-4-(4-tert-octylphenoxy)naphthalene-1,8-dicarboximide, *N*-(phenyl)-4-(4-isopropylphenoxy)naphthalene-1,8-dicarboximide, *N*-(phenyl)-4-(4-tert-pentylphenoxy)naphthalene-1,8-dicarboximide, *N*-(2-ethylhexyl)-4-(4-tert-octylphenoxy)naphthalene-1,8-dicarboximide, *N*-(2-ethylhexyl)-4-(4-isopropylphenoxy)naphthalene-1,8-dicarboximide, *N*-(2-ethylhexyl)-4-(4-tert-pentylphenoxy)naphthalene-1,8-dicarboximide, and *N*-(2,4,6-trimethylphenyl)-4-(4-tert-octylphenoxy)naphthalene-1,8-dicarboximide.

The compounds of the formula I-A

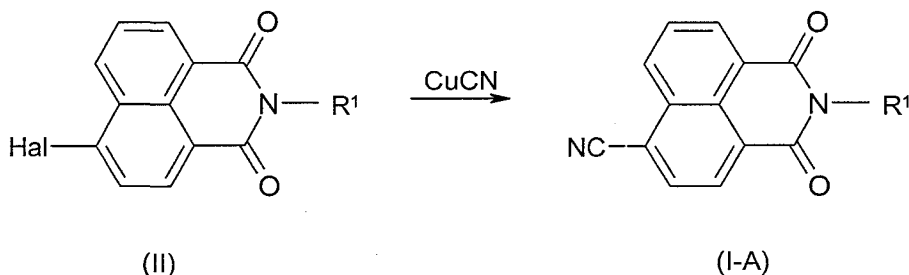


where

R^1 has the suitable and preferred definitions specified above

can be prepared for example by reacting 4-halo naphthalene-1,8-dicarboximides II with copper(I) cyanide in accordance with scheme 1.

Scheme 1:



In scheme 1 Hal is halogen, such as fluorine, bromine, chlorine or iodine, particularly bromine or iodine. R^1 is as defined above. R^1 is preferably C_1 - C_{12} alkyl, C_5 - C_8 cycloal-

kyl or phenyl, the two last-mentioned radicals each being unsubstituted or carrying one, two, three, four or five C₁-C₄ alkyl groups.

5 The reaction takes place normally in an organic solvent which contains nitrogen and is inert under the reaction conditions. Examples of suitable organic solvents which contain nitrogen include aromatic nitrogen heterocycles such as pyridine, 2-methylpyridine, 3-methylpyridine or 4-methylpyridine, quinoline or isoquinoline, N,N-dialkylcarboxamides such as N,N-dimethylformamide or N,N-dimethylacetamide, and N-alkyl lactams such as N-methylpyrrolidone.

10 The reaction takes place generally at a temperature between room temperature and the boiling temperature of the solvent, preferably at temperatures between 40°C and the boiling temperature of the solvent, and in particular at the boiling temperature of the solvent.

15 The compound II and the copper(I) cyanide are normally employed in approximately equimolar amounts. It may also be of advantage, however, to use one of the two reactants in excess. In one preferred embodiment the copper(I) cyanide is used in excess, relative to the compound II.

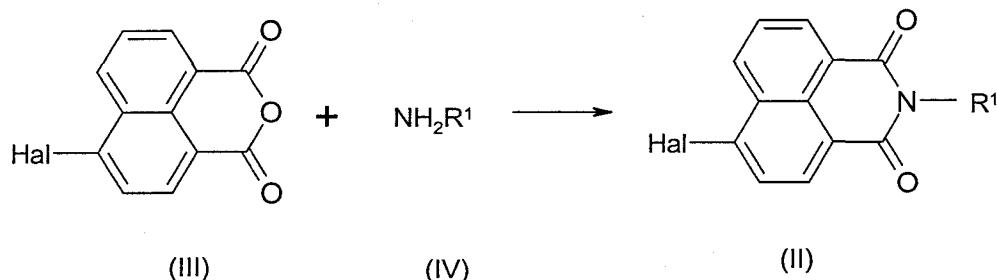
20 It may also be of advantage to carry out the reaction in the presence of metal iodides, preferably transition metal iodides, and in particular copper(I) iodide.

25 The reaction mixture is worked up generally by diluting with water and the product is isolated by filtration. Where appropriate the product can be purified in a customary way, by crystallization or chromatography for example.

30 In order to remove the copper salts, particularly the copper(I) salts, from the product it may be advantageous to convert the salts into copper(II) salts by oxidation in aqueous solution, with hydrogen peroxide or iron(III) salts, for example, and then to isolate the product by extraction with an organic, water-immiscible solvent. Moreover, copper salts can be removed by treatment with aqueous solutions of complexing reagents, such as ammonia, organic monoamines or diamines, and soluble cyanide salts. An alternative option is to extract the product with organic solvents, e.g., chlorinated hydrocarbons such as dichloromethane or 1,2-dichloroethane or ketones such as acetone, with the aid, for example, of a Soxhlet apparatus, from the crude product.

40 The 4-halonaphthalene-1,8-dicarboximides II can be prepared for example by reacting 4-halonaphthalene-1,8-dicarboxylic anhydrides III with a primary amine IV in accordance with the reaction sequence depicted in scheme 2.

Scheme 2:



In scheme 2 Hal is halogen, such as fluorine, bromine, chlorine or iodine, particularly bromine or iodine, and R^1 is as defined above.

5

The reaction according to scheme 2 is carried out if desired in the presence of a catalyst. Examples of suitable catalysts are Lewis acids, such as metal ions in the form of their salts, Zn(II) acetate being one example, Brönstedt acids, such as organic carboxylic acids, examples being acetic acid, adipic acid or mineral acids such as sulfuric acid, Brönstedt bases, such as tertiary amines, triethylamine being one example, or mixtures of Brönstedt bases and Brönstedt acids.

10

The reaction is normally carried out in an organic solvent which is inert under the reaction conditions. Examples of suitable inert organic solvents include solvents containing nitrogen, e.g., aromatic nitrogen heterocycles such as pyridine, 2-methylpyridine, 3-methylpyridine, 4-methylpyridine, quinoline or isoquinoline, N,N-dialkylcarboxamides such as N,N-dimethylformamide or N,N-dimethylacetamide, N-alkyl lactams such as N-methylpyrrolidone, or aromatic solvents such as toluene or xylene.

15

In general the reaction takes place at a temperature between room temperature and the boiling temperature of the solvent, preferably at elevated temperature, and in particular at the boiling temperature of the solvent.

20

It is normal to employ the compound III and the amine IV in approximately equimolar amounts. It may, however, also be of advantage to employ one of the two reactants in excess.

25

It can be advantageous to remove the water formed during the reaction from the reaction mixture, employing a water separator, for example.

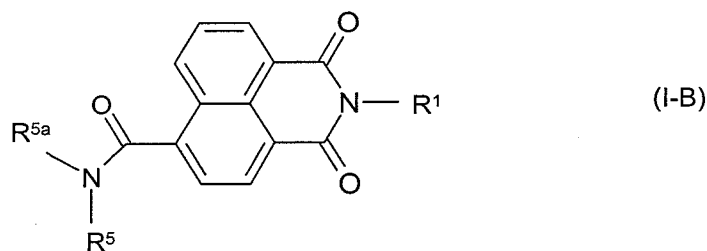
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The reaction mixture is worked up by cooling it, diluting it with water where appropriate, and isolating the product by filtration. The product can if desired be purified in a customary way, by crystallization or chromatography for example.

35

The 4-halonaphthalene-1,8-dicarboxylic anhydrides III are known from the literature or can be prepared by known methods. For bromo derivatives see, for example, Graebe, Guinsbourg, *Justus Liebigs Ann. Chem.* 1903, 327, 86 or Rule, Thompson, *J. Chem. Soc.* 1937, 1764. For the chloro derivatives see, for example, Xuhong, Shengwu, *J. Chem. Eng. Data* 1988, 33, 528-529.

The compounds I-B



where

R^1 is as defined above and

R^5 and R^{5a} each independently of one another are hydrogen, C_1 - C_{18} alkyl, aryl or heteroaryl, with aryl and heteroaryl in each case being unsubstituted or carrying one or more substituents selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, hydroxyl, carboxyl, and cyano;

can be prepared for example by hydrolyzing the naphthalene-1,8-dicarboxylic monoimides I-A. Where R^5 and R^{5a} are radicals other than hydrogen, hydrolysis is followed by alkylation of the 4-aminocarbonyl compound I-B.

The hydrolysis can take place under atmospheric pressure or superatmospheric pressure. The hydrolysis can be accelerated by superatmospheric pressure, elevated temperature and/or addition of a catalyst. In one preferred embodiment the hydrolysis takes place in the presence of a catalyst. Suitable catalysts are transition metal oxides, such as iron oxides, concentrated acids such as sulfuric acid or phosphoric acid, or hydrogen peroxide in basic solution. Where concentrated acids are used as catalysts they may also act as solvents at the same time. Preference is given to using sulfuric acid as catalyst.

The hydrolysis normally takes place at temperatures between room temperature and the boiling point of the mixture: for example, at temperatures between 50 and 90°C.

Compounds of the formula I-B in which R^{5a} and/or R^5 are other than hydrogen can be obtained for example by first subjecting a compound I-B in which R^5 and R^{5a} are hydrogen to reaction

(a) with an alkylating agent

R^5 -L (V)

where R^5 is as defined above and L is a nucleophilically displaceable leaving group and, if desired, subsequently subjecting the monoalkylated reaction product obtained in step a to reaction

(b) with an alkylating agent



5

in which R^{5a} is as defined above and L is a nucleophilically displaceable leaving group.

10 Examples of a suitable, nucleophilically displaceable leaving group L are halide, preferably chloride, bromide or iodide, sulfate, C_1 - C_{18} alkylsulfonyloxy, C_1 - C_{18} haloalkylsulfonyloxy, C_1 - C_{18} alkoxy sulfonyloxy, or phenylsulfonyloxy, in which the phenyl radical is unsubstituted or substituted one or more times by halo, nitro or C_1 - C_6 alkyl, such as phenylsulfonyloxy, p-toluenesulfonyloxy, p-chlorophenylsulfonyloxy, p-bromophenylsulfonyloxy or p-nitrophenylsulfonyloxy.

15 The alkylation is normally carried out in the presence of a base. Suitable bases include in principle any compounds capable of deprotonating the amide nitrogen atom. Examples of suitable bases include alkali metal and alkaline earth metal carbonates such as lithium carbonate, sodium carbonate, potassium carbonate, and cesium carbonate, or alkali metal and alkaline earth metal hydroxides such as sodium hydroxide, potassium
20 hydroxide, and lithium hydroxide.

The base can be used in substoichiometric, superstoichiometric or equimolar amount, relative to the compound I-B. It is preferred to employ at least an equimolar amount of base, relative to the compound I-B.

25

The reaction of the compounds I-B where R^5 and R^{5a} = hydrogen with the alkylating agent (V) is advantageously carried out in the presence of a solvent. Solvents used for these reactions – depending on temperature range – are aliphatic, cycloaliphatic or aromatic hydrocarbons such as hexane, cyclohexane, toluene, and xylene, chlorinated
30 aliphatic and aromatic hydrocarbons such as dichloromethane and chlorobenzene, open-chain dialkyl ethers such as diethyl ether, di-n-propyl ether, and methyl tert-butyl ether, cyclic ethers such as tetrahydrofuran and 1,4-dioxane, and glycol ethers such as dimethyl glycol ether, or mixtures of these solvents.

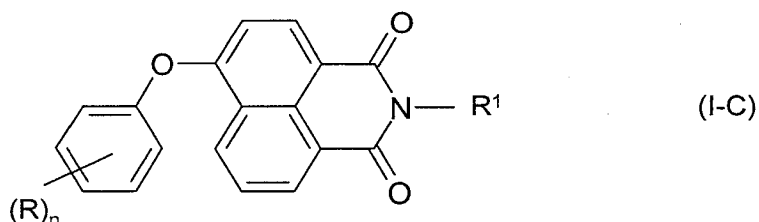
35 It can be advantageous to carry out the reaction in the presence of a phase transfer catalyst, especially when using inorganic bases whose solubility in the reaction medium is poor. Examples of suitable phase transfer catalysts in this context include quaternary ammonium salts or phosphonium salts. Suitable quaternary ammonium salts include tetra(C_1 - C_{18} alkyl)ammonium chlorides, bromides, fluorides and tetrafluoroborates, such
40 as tetraethylammonium chloride, tetrabutylammonium bromide, tetrabutylammonium iodide, and tetrabutylammonium tetrafluoroborate, benzyltri(C_1 - C_{18} alkyl)ammonium chlorides, bromides, and fluorides, an example being benzyltriethylammonium chloride. Suitable phosphonium salts are tetra(C_1 - C_{18} alkyl)phosphonium chlorides or bromides such as tetrabutylphosphonium bromide or tetraphenylphosphonium chloride or
45 bromide. Further suitable phase transfer catalysts are crown ethers, an example being 18-crown-6.

The reaction temperature is situated generally between room temperature and the boiling temperature of the solvent.

- 5 The reaction of the resultant compound I-B where $R^5 \neq$ hydrogen with the alkylating agent VI for the preparation of compounds where R^5 and $R^{5a} \neq$ hydrogen takes place by a process analogous to that described above, for the preparation of compounds I-B where $R^5 \neq$ hydrogen. With regard to suitable bases, solvents, and reaction temperatures, refer to the comments made above.

10

Compounds of the formula I-C



15 where

R^1 is as defined above,

R stands for identical or different C_1 - C_{12} alkyl groups; and

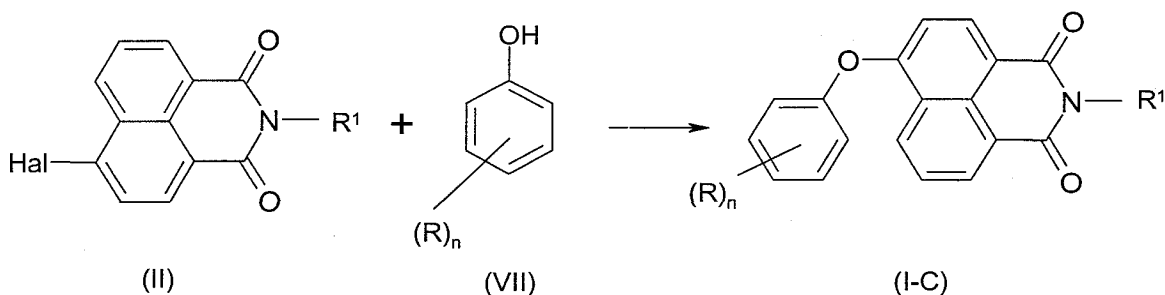
n is 1, 2, 3, 4 or 5

20

can be obtained for example by reacting a compound II with a phenol VII in accordance with the reaction sequence shown in scheme 3.

Scheme 3:

25



In scheme 3 Hal is halogen, such as fluorine, chlorine, bromine or iodine, preferably fluorine or chlorine. R , n and R^1 have the definitions given above, preferably the preferred definitions.

30

The reaction of the compound II with the compound VII is preferably carried out in the presence of a base. Examples of suitable inorganic bases are alkali metal and alkaline earth metal carbonates such as lithium carbonate, sodium carbonate, potassium car-

bonate or cesium carbonate, alkali metal and alkaline earth metal hydrogencarbonates such as lithium hydrogencarbonate, sodium hydrogencarbonate, potassium hydrogencarbonate or cesium hydrogencarbonate, alkali metal and alkaline earth metal hydroxides such as sodium hydroxide, potassium hydroxide, and lithium hydroxide, and alkali metal and alkaline earth metal hydrides such as sodium hydride and potassium hydride. Examples of suitable organic bases include tertiary amines such as trialkylamines, e.g. triethylamine, tri-n-propylamine, N-ethyldiisopropylamine, cycloaliphatic amines such as N,N-dimethylcyclohexylamine, cyclic amines such as N-methylpyrrolidine, N-ethylpiperidine, diazabicycloundecene, and diazabicyclooctane, and aromatic nitrogen heterocycles such as pyridine, α -, β - or γ -picoline, 2,4- and 2,6-lutidine, quinoline, quinazoline, quinoxaline, p-dimethylaminopyridine, pyrimidine and the like.

In the case of salts whose solubility in the reaction medium is poor it can be of advantage to carry out the reaction in the presence of a phase transfer catalyst. Examples of suitable phase transfer catalysts in this context include quaternary ammonium salts or phosphonium salts. Suitable quaternary ammonium salts include tetra(C₁-C₁₈ alkyl)ammonium chlorides, bromides, fluorides and tetrafluoroborates, such as tetraethylammonium chloride, tetrabutylammonium bromide, tetrabutylammonium iodide, and tetrabutylammonium tetrafluoroborate, benzyltri(C₁-C₁₈ alkyl)ammonium chlorides, bromides, and fluorides, an example being benzyltriethylammonium chloride. Suitable phosphonium salts are tetra(C₁-C₁₈ alkyl)phosphonium chlorides or bromides such as tetrabutylphosphonium bromide or tetraphenylphosphonium chloride or bromide. Further suitable phase transfer catalysts are crown ethers, an example being 18-crown-6.

The reaction is normally carried out in an organic solvent. Examples of suitable organic solvents are solvents containing nitrogen, such as aromatic nitrogen heterocycles like pyridine, 2-methylpyridine, 3-methylpyridine, 4-methylpyridine, isoquinoline or quinoline, N,N-dialkylcarboxamides such as N,N-dimethylformamide or N,N-dimethylacetamide, N-alkyl lactams such as N-methylpyrrolidone, and aromatic solvents such as xylene or toluene.

Generally speaking, the reaction takes place at a temperature between room temperature and the boiling temperature of the solvent, preferably at elevated temperature, and in particular at the boiling temperature of the solvent.

The compound II and the phenol VII are normally employed in approximately equimolar amounts. It can, however, also be of advantage to use one of the two reactants in excess.

The reaction mixture is generally worked up by cooling it, diluting it where appropriate with water, and isolating the product by filtration. Where appropriate the product can be purified in a customary way, by crystallization or chromatography for example.

The naphthalene-1,8-dicarboxylic monoimides of the formula I are capable of absorbing in the wavelength range below 400 nm with preference, and below 390 nm in particular. The transmittance of the stabilized material for electromagnetic radiation with a wavelength between 340 nm and 380 nm is preferably not greater than 10%.

5

The naphthalene-1,8-dicarboxylic monoimides I used in accordance with the invention are suitable for protecting orgaryl material. Organic material for the purposes of the present invention embraces both living orgaryl material and inanimate orgaryl material. Protection includes both direct protection, as obtained by mixing the material to be protected with at least one naphthalene-1,8-dicarboxylic monoimide of the formula I, and the indirect protection of the materials which are least partly surrounded by a directly protected material (in the form of packaging, for example). An example of living orgaryl material is skin and an example of inanimate orgaryl material is hair. Examples of inanimate orgaryl material also include, for example, foods, cleaning products, perfumes, textiles, cosmetic preparations such as ointments, creams, gels, emulsions, and lotions, drug formulations such as drops, emulsions, solutions, pills, tablets, and suppositories, paints, photographic emulsions, photographic layers, and particularly plastics and polymer dispersions.

10

15

One preferred embodiment of the present invention relates to the use of at least one naphthalene-1,8-dicarboxylic monoimide of the formula I to stabilize inanimate organic material.

20

The naphthalene-1,8-dicarboxylic monoimides I are used in particular for stabilizing plastics. The naphthalene-1,8-dicarboxylic monoimides I used in accordance with the invention show themselves to be highly compatible with plastics, so that the optical properties of the polymer are unaffected. Moreover, many of the naphthalene-1,8-dicarboxylic monoimides I used in accordance with the invention display a weak fluorescence, so that additizing the plastic with at least one naphthalene-1,8-dicarboxylic monoimide I is capable of masking or reducing any intrinsic yellow coloration of the plastic. Preferred plastics are those which are transparent in the uncolored state in the visible wavelength range. These include not only homopolymers and copolymers but also polymer blends. Naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention protects plastic and in the case of transparent plastics also protects living and/or inanimate orgaryl material at least partly surrounded by the directly protected plastic against the damaging effects of light.

25

30

35

One embodiment of the present invention relates to the use of naphthalene-1,8-dicarboxylic monoimides I in plastics used as packaging materials.

40

The plastics preferably comprise at least one polymer selected from polyesters, polycarbonates, polystyrene, copolymers of styrene or α -methylstyrene with dienes and/or acrylic derivatives, polyurethanes, polyvinyl acetals, polyolefins, polyacrylates, and polymer blends of said polymers, and the reaction products stated when at least two of said polymers are intimately mixed.

45

The expression "polymer blends" is understood in the context of the present invention to refer to physical mixtures of polymers. The expression "the reaction products stated when at least two of said polymers are intimately mixed" refers in the context of the present invention to the reaction products of polymers that are formed, when at least
5 two polymers are intimately contacted, by chemical reactions, such as transesterifications or graftings. The intimate contacting may take place for example in an extruder when the polymers are melted.

10 Preference is given to polymers and polymer mixtures (polymer blends) which can be processed to highly transparent, glass-clear packs or packaging materials.

In one preferred embodiment of the invention the plastic comprises as polymer at least one polyester, preferably at least one linear polyester. Suitable polyesters and copolyesters are described in EP-A-0678376, EP-A-0 595 413 and US 6,096,854, hereby
15 incorporated by reference. Polyesters, as is known, are condensation products of one or more polyols and one or more polycarboxylic acids. In linear polyesters the polyol is a diol and the polycarboxylic acid is a dicarboxylic acid. The diol component may be selected from ethylene glycol, 1,4-cyclohexanedimethanol, 1,2-propanediol, 1,3-propanediol, 1,4-butanediol, 2,2-dimethyl-1,3-propanediol, 1,6-hexanediol,
20 1,2-cyclohexanediol, 1,4-cyclohexanediol, 1,2-cyclohexanedimethanol, and 1,3-cyclohexanedimethanol. Also suitable are diols whose alkylene chain is interrupted one or more times by nonadjacent oxygen atoms. Such diols include diethylene glycol, triethylene glycol, dipropylene glycol, tripropylene glycol, and the like. In general the diol contains from 2 to 18 carbon atoms, preferably 2 to 8 carbon atoms. Cycloaliphatic
25 diols can be used in the form of their cis or trans isomer or as an isomer mixture. The acid component can be an aliphatic, alicyclic or aromatic dicarboxylic acid. the acid component of linear polyesters is generally selected from terephthalic acid, isophthalic acid, 1,4-cyclohexanedicarboxylic acid, 1,3-cyclohexanedicarboxylic acid, succinic acid, glutaric acid, adipic acid, sebacic acid, 1,12-dodecanedioic acid,
30 2,6-naphthalenedicarboxylic acid, and mixtures thereof. It will be appreciated that the functional derivatives of the acid component can also be used, such as esters, the methyl ester for example, anhydrides or halides, preferably chlorides. Preferred polyesters are polyalkylene terephthalates and polyalkylene naphthalenes obtainable by condensing terephthalic acid or naphthalenedicarboxylic acid, respectively, with an ali-
35 phatic diol.

Particularly preferred polyalkylene terephthalates are polyethylene terephthalates (PET), which are obtained by condensing terephthalic acid with diethylene glycol. PET
40 is also obtainable by transesterifying dimethyl terephthalate with ethylene glycol, with elimination of methanol, to form bis(2-hydroxyethyl) terephthalate, and subjecting the product to polycondensation, releasing ethylene glycol. Further preferred polyesters are polybutylene terephthalates (PBT), obtainable by condensing terephthalic acid with 1,4-butanediol, polyethylene 2,6-naphthalate (PEN), poly-1,4-cyclohexanedimethylene terephthalates (PCT), and also copolyesters of polyethylene terephthalate with cyclo-
45 hexanedimethanol (PDCT) and of polybutylene terephthalate with cyclohexanedimethanol. Preference is likewise given to copolymers, transesterification products, and

mixtures (blends) of the aforementioned polyalkylene terephthalates. Particularly suitable thermoplastic molding compounds are selected from polycondensates and copolycondensates of terephthalic acid, such as poly- or copolyethylene terephthalate (PET or CoPET or PETG), poly(ethylene 2,6-naphthalate)s (PEN) or PEN/PET copolymers and PEN/PET blends. Said copolymers and blends, depending on their preparation process, may also include fractions of transesterification products.

In further preferred embodiment of the invention the plastic comprises polycarbonates as polymers. Polycarbonates are formed, for example, by condensation of phosgene or carbonic esters such as diphenyl carbonate or dimethyl carbonate with dihydroxy compounds. Suitable dihydroxy compounds are aliphatic or aromatic dihydroxy compounds. Examples of aromatic dihydroxy compounds include bisphenols such as 2,2-bis(4-hydroxyphenyl)propane (bisphenol A), tetraalkylbisphenol A, 4,4-(meta-phenylenediisopropyl)diphenol (bisphenol M), 4,4-(para-phenylenediisopropyl)diphenol, 1,1-bis(4-hydroxyphenyl)-3,3,5-trimethylcyclohexane (BP-TMC), 2,2-bis(4-hydroxyphenyl)-2-phenylethane, 1,1-bis(4-hydroxyphenyl)cyclohexane (bisphenol Z) and, where appropriate, mixtures thereof. The polycarbonates may be branched by using small amounts of branching agents. Suitable branching agents include phloroglucinol, 4,6-dimethyl-2,4,6-tri(4-hydroxyphenyl)hept-2-ene, 4,6-dimethyl-2,4,6-tri(4-hydroxyphenyl)heptane; 1,3,5-tri(4-hydroxyphenyl)benzene; 1,1,1-tri(4-hydroxyphenyl)heptane; 1,3,5-tri(4-hydroxyphenyl)benzene; 1,1,1-tri(4-hydroxyphenyl)ethane; tri(4-hydroxyphenyl)phenylmethane, 2,2-bis[4,4-bis(4-hydroxyphenyl)-cyclohexyl]propane; 2,4-bis(4-hydroxyphenylisopropyl)phenol; 2,6-bis(2-hydroxy-5'-methylbenzyl)-4-methylphenol; 2-(4-hydroxyphenyl)-2-(2,4-dihydroxyphenyl)propane; hexa(4-(4-hydroxyphenylisopropyl)phenyl) orthoterephthalate; tetra(4-hydroxyphenyl)-methane; tetra(4-(4-hydroxyphenylisopropyl)phenoxy)methane; a,a',a''-tris(4-hydroxyphenyl)-1,3,5-trisopropylbenzene; 2,4-dihydroxybenzoic acid; trimesic acid; cyanuric chloride; 3,3-bis(3-methyl-4-hydroxyphenyl)-2-oxo-2,3-dihydroindole, 1,4-bis(4',4''-dihydroxytriphenyl)methyl)benzene, and, in particular, 1,1,1-Tri(4-hydroxyphenyl)ethane and bis(3-methyl-4-hydroxyphenyl)-2-oxo-2,3-dihydroindole.

For chain termination, suitability is possessed by, for example, phenols such as phenol, alkylphenols such as cresol and 4-tert-butylphenol, chlorophenol, bromophenol, cumylphenol or mixtures thereof. The fraction of chain terminators is generally from 1 to 20 mol%, per mole of dihydroxy compound.

In another suitable embodiment of the invention the plastic comprises polymers derived from α,β -unsaturated acids and derivatives thereof, e.g., poly(meth)acrylates such as polymethyl methacrylate (PMMA) and polyethyl methacrylate.

In a further suitable embodiment of the invention the plastic comprises as polymer a vinylaromatic homopolymer or copolymer such as polystyrene (PS) or copolymers of styrene or α -methylstyrene with dienes and/or acrylic derivatives, such as styrene-butadiene, styrene-acrylonitrile (SAN), styrene-ethyl methacrylate, styrene-butadiene-ethyl acrylate, styrene-acrylonitrile-methacrylate, acrylonitrile-butadiene-styrene (ABS) or methyl methacrylate-butadiene-styrene (MBS).

15 In a further suitable embodiment of the invention the plastic comprises polymers derived from unsaturated alcohols and amines or from their acrylic derivatives or acetals, such as polyvinyl acetate (PVAC) and polyvinyl alcohol (PVAL). The reaction of polyvinyl alcohol with an aldehyde forms polyvinyl acetals: for example, polyvinyl formals (PVFM) on reaction with formaldehyde, or the polyvinyl butyrals (PVB) with butyraldehyde.

10 In laminated glass, two or more sheets of glass are bonded together adhesively through polyvinyl butyral film. The polyvinyl butyral molding compound generally has an average molecular mass of more than 70 000, preferably from about 100 000 to 250 000. The polyvinyl butyral generally has a residual hydroxyl group content of less than 19.5%, preferably from about 17% to 19% by weight, calculated as polyvinyl alcohol, and a residual ester group content of from 0 to 10%, preferably from 0 to 3%, calculated as polyvinyl ester. An exemplary PVB is obtainable commercially under the name Butvar® from Solutia, Inc. of St. Louis, Mo. Any glass is suitable provided it is transparent for light in the visible wavelength range. Such glasses include normal clear soda-lime glass, IR-reflecting coated glass or IR-absorbing glass; see, e.g.,
15 US 3,944,352 and US 3,652,303. With respect to the configuration of laminated glass, the entirety of WO 02/077081, and in particular pages 28 to 32, is hereby incorporated by reference.
20

For the purposes of the present invention the term "polyolefin" embraces all polymers synthesized from olefins without further functionality, such as low or high density polyethylene, polypropylene, linear polybut-1-ene or polyisobutylene or polybutadiene, and also copolymers of monoolefins or diolefins. Preferred polyolefins are the homopolymers and copolymers of ethylene and also the homopolymers and copolymers of propylene.
25

30 Ethylene polymers:

Suitable polyethylene (PE) homopolymers are, for example:

- 35 - PE-LD (LD = low density), obtainable for example by the high-pressure process (ICI) at 1000 to 3000 bar and 150 to 300°C with oxygen or peroxide catalysts in autoclaves or tube reactors. Highly branched with branches of different length, crystallinity 40 to 50%, density 0.915 to 0.935 g/cm³, average molar mass up to 600 000 g/mol.
- 40 - PE-LLD (LLD = linear low density), obtainable with metal complex catalysts in the low-pressure process from the gas phase, from a solution (e.g., mineral spirit), in a suspension or with a modified high-pressure process. Slight branching with side chains which are themselves unbranched, molar masses higher than for PE-LD.

45

- PE-HD (HD = high density), obtainable by the medium-pressure (Phillips) and low-pressure (Ziegler) processes. According to Phillips at 30 to 40 bar, 85 to 180°C, chromium oxide catalyst, molar masses about 50 000 g/mol. According to Ziegler at 1 to 50 bar, 20 to 150°C, titanium halide, titanate ester or aluminum alkyl catalysts, molar mass about 200 000 to 400 000 g/mol. Carried out in suspension, solution, gas phase or bulk. Very slight branching, crystallinity 60 to 80%, density 0.942 to 0.965 g/cm³.
- PE-HD-HMW (HMW = high molecular weight), obtainable by Ziegler, Phillips or gas-phase method. High density and high molar mass.
- PE-HD-UHMW (UHMW = ultra-high molecular weight) obtainable with modified Ziegler catalyst, molar mass 3 000 000 to 6 000 000 g/mol.

Particular suitability is possessed by polyethylene prepared in a gas-phase fluidized-bed process using (normally supported) catalysts, e.g., Lupolen® (Basell).

Particular preference is given to polyethylene prepared using metallocene catalysts. Polyethylene of this kind is available commercially as Luflexen® (Basell), for example.

Suitable ethylene copolymers include all commercially customary ethylene copolymers, examples being Luflexen® grades (Basell), Nordel®, and Engage® (Dow, DuPont). Examples of suitable comonomers include α -olefins having 3 to 10 carbon atoms, especially propylene, but-1-ene, hex-1-ene, and oct-1-ene, and also alkyl acrylates and methacrylates having 1 to 20 carbon atoms in the alkyl radical, especially butyl acrylate. Further suitable comonomers are dienes such as butadiene, isoprene, and octadiene, for example. Other suitable comonomers are cycloolefins, such as cyclopentene, norbornene, and dicyclopentadiene.

The ethylene copolymers are normally random copolymers or block or impact copolymers. Suitable block or impact copolymers of ethylene and comonomers are, for example, polymers for which in the first stage a homopolymer of the comonomer or a random copolymer of the comonomer is prepared, containing up to 15% by weight ethylene, for example, and then in the second stage a comonomer-ethylene copolymer with ethylene contents of 15 to 80% by weight is polymerized on. Ordinarily, sufficient of the comonomer-ethylene copolymer is polymerized on for the copolymer produced in the second stage to have a fraction of from 3 to 60% by weight in the end product.

The polymerization for preparing the ethylene-comonomer copolymers can take place by means of Ziegler-Natta catalyst system. It is, however, also possible to use catalyst systems based on metallocene compounds or based on polymerization-active metal complexes.

Propylene polymers:

Polypropylene should be understood below to refer both to homopolymers and to copolymers of propylene. Copolymers of propylene contain minor amounts of monomers copolymerizable with propylene, examples being C₂-C₈ alk-1-enes such as ethylene, but-1-ene, pent-1-ene or hex-1-ene, among others. Two or more different comonomers
5 can also be used.

Suitable polypropylenes include homopolymers of propylene or copolymers of propylene with up to 50% by weight of copolymerized other alk-1-enes having up to 8 carbon atoms. The copolymers of propylene are in this case random copolymers or block or
10 impact copolymers. Where the copolymers of propylene are of random construction they contain generally up to 15% by weight, preferably up to 6% by weight, of other alk-1-enes having up to 8 carbon atoms, especially ethylene, but-1-ene or a mixture of ethylene and but-1-ene.

Suitable block or impact copolymers of propylene are, for example, polymers for which in the first stage a propylene homopolymer or a random copolymer of propylene with up to 15% by weight, preferably up to 6% by weight, of other alk-1-enes having up to 8 carbon atoms is prepared and then in the second stage a propylene-ethylene copolymer having ethylene contents of from 15 to 80% by weight is polymerized on, it
20 being possible for the propylene-ethylene copolymer further to include other C₄-C₈ alk-1-enes. Ordinarily, sufficient of the propylene-ethylene copolymer is polymerized on that the copolymer produced in the second stage has a fraction of from 3 to 60% by weight in the end product.

The polymerization for the preparation of polypropylene can take place by means of a Ziegler-Natta catalyst system. Use is made in particular of catalyst systems which in addition to a solid component a) containing titanium also contain cocatalysts in the form of organic aluminum compounds b) and electron donor compounds c).

It is also possible, however, to use catalyst systems based on metallocene compounds or based on polymerization-active metal complexes.

The preparation of the polypropylenes is normally carried out by polymerization in at least one reaction zone or, frequently, in two or more reaction zones connected in series (a reactor cascade), in the gas phase, in a suspension, or in a liquid phase (bulk phase). The reactors used can be the normal reactors used for polymerizing C₂-C₈ alk-1-enes. Suitable reactors include continuous stirred tanks, loop reactors, powder bed reactors or fluidized bed reactors.

The polymerization for preparing the polypropylenes used is operated under normal reaction conditions at temperatures from 40 to 120°C, in particular from 50 to 100°C, and pressures from 10 to 100 bar, in particular from 20 to 50 bar.

Suitable polypropylenes normally have a melt flow rate (MFR) in accordance with
45 ISO 1133 of from 0.1 to 200 g/10 min., in particular from 0.2 to 100 g/10 min., at 230°C and under a weight of 2.16 kg.

In another embodiment of the invention the plastic comprises at least one polyolefin. Preferred polyolefins contain at least one copolymerized monomer selected from ethylene, propylene, but-1-ene, isobutylene, 4-methyl-1-pentene, butadiene, isoprene, and mixtures thereof. Suitability is possessed by homopolymers, copolymers of the stated olefin monomers, and copolymers of at least one of said olefins as principal monomer, with other monomers (such as vinylaromatics, for example) as comonomers.

Preferred polyolefins are low density polyethylene homopolymers (PE-LD) and polypropylene homopolymers and polypropylene copolymers. Preferred polypropylenes are, for example, biaxially oriented polypropylene (BOPP) and crystallized polypropylene.

In another embodiment of the invention the plastic comprises as polymer at least one polyurethane. Polyurethanes are, generally speaking, addition products of at least one diisocyanate and at least one diol component, which may also contain higher polyfunctional isocyanates, triisocyanates for example, and higher polyfunctional polyols. Suitable isocyanates are aromatic diisocyanates such as 2,4- and 2,6-tolylene diisocyanate (TDI) and isomer mixtures thereof, tetramethylxylene diisocyanate (TMXDI), xylene diisocyanate (XDI), and diphenylmethane 4,4'-diisocyanate (MDI), and aliphatic diisocyanates, such as dicyclohexylmethane 4,4'-diisocyanate (H_{12} MDI), tetramethylene diisocyanate, hexamethylene diisocyanate (HMDI), isophorone diisocyanate (IPDI), trimethylhexamethylene diisocyanate, and mixtures thereof. The preferred diisocyanates include hexamethylene diisocyanate (HMDI) and isophorone diisocyanate. Also suitable for preparing polyurethanes are triisocyanates, e.g. triphenylmethane 4,4',4''-triisocyanate, and the cyanurates and biurets of the aforementioned diisocyanates.

Suitable diols are glycols having preferably 2 to 25 carbon atoms. These include 1,2-ethanediol, 1,2-propanediol, 1,3-propanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 1,10-decanediol, diethylene glycol, 2,2,4-trimethylpentane-1,5-diol, 2,2-dimethylpropane-1,3-diol, 1,4-dimethylolcyclohexane, 1,6-dimethylolcyclohexane, 2,2-bis(4-hydroxyphenyl)propane (bisphenol A), 2,2-bis(4-hydroxyphenyl)butane (bisphenol B) or 1,1-bis(4-hydroxyphenyl)-3,3,5-trimethylcyclohexane (bisphenol C).

Polyols are also useful starting materials for preparing polyurethanes. By polyols are meant trivalent alcohols (known as triols) and higher polyfunctional alcohols. They have generally 3 to 25, preferably 3 to 18, carbon atoms. They include glycerol, trimethylolpropane, trimethylolpropane, erythritol, pentaerythritol, sorbitol, and the alkoxylates thereof.

In one preferred embodiment of the present invention the plastic is a thermoplastic molding compound. The transmittance of the uncolored thermoplastic molding compound for electromagnetic radiation with a wavelength between 420 nm and 800 nm is preferably greater than 90%.

The present invention further provides for the use of at least one naphthalene-1,8-dicarboxylic monoimide I for preparing a layer which absorbs ultraviolet light. The layer which absorbs ultraviolet light can function as a heat insulator. The absorbent layer is preferably transparent in the wavelength range between 420 and 800 nm.

5 The ultraviolet-absorbing, preferably transparent layer comprises a thermoplastic molding compound. Suitable thermoplastic molding compounds include thermoplastics comprising at least one polymer selected from polyesters, polycarbonates, polyolefins, polyvinyl acetals, polystyrene, copolymers of styrene or of α -methylstyrene with dienes
10 and/or acrylic derivatives, and also hybrid forms of the aforementioned polymers.

In one preferred embodiment of the present invention the transparent layer is part of an architectural or automotive glazing system or is a sheet intended for adhesive bonding to glass or plastic for purposes of insulation; in particular it is part of a laminated win-
15 dows in automotive glazing. In one particularly preferred embodiment the plastic sheet comprises a polyvinyl acetal, in particular polyvinyl butyral.

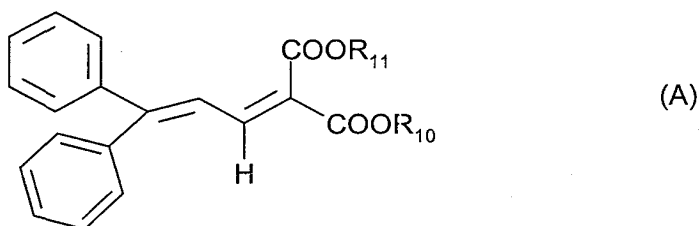
The naphthalene-1,8-dicarboxylic monoimide I in the laminated glass acts as a UV absorber to protect living organic and inanimate organic material, so that, for example, the
20 driver and the inanimate organic material present in the car interior are protected against the damaging effects of ultraviolet radiation. Examples of possible damage include erythema or sunburn in the case of living organic material and yellowing, discoloration, cracking or embrittlement in the case of inanimate organic material.

25 Optionally the plastic further comprises at least one other light stabilizer which absorbs light radiation in the UV-A and/or UV-B region, and/or further costabilizers. The light stabilizer and, where appropriate, costabilizers used additionally must of course be compatible with the naphthalene-1,8-dicarboxylic monoimide I. In the visible range it is preferably colorless or has only a slight inherent coloration. The light stabilizers and/or
30 costabilizers, where used, preferably have high migration fastness and temperature stability. Suitable light stabilizers and further costabilizers are selected, for example, from groups a) to s):

- a) 4,4-diarylbutadienes,
- 35 b) cinnamic esters,
- c) 2-(2'-hydroxyphenyl)-benzotriazoles,
- d) 2-hydroxybenzophenones,
- e) diphenylcyanacrylates,
- f) oxamides,
- 40 g) 2-(2-hydroxyphenyl)-1,3,5-triazines and
- h) antioxidants,
- i) nickel compounds,
- j) sterically hindered amines,
- k) metal deactivators,
- 45 l) phosphites and phosphonites,
- m) hydroxylamines,

- n) nitrones,
- o) amine oxides,
- p) benzofuranones and indolinones,
- q) thiosynergists,
- 5 r) peroxide-destroying compounds, and
- s) basic costabilizers.

Group a) of the 4,4-diarylbutadienes includes for example compounds of the formula A.



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The compounds are known from EP-A-916 335. The substituents R_{10} and/or R_{11} are preferably C_1 - C_8 alkyl and C_5 - C_8 cycloalkyl.

- Group b) of the cinnamic esters includes for example 2-isoamyl 4-methoxycinnamate, 2-ethylhexyl 4-methoxycinnamate, methyl α -methoxycarbonylcinnamate, methyl α -cyano- β -methyl-p-methoxycinnamate, butyl α -cyano- β -methyl-p-methoxycinnamate, and methyl α -methoxycarbonyl-p-methoxycinnamate.

- Group c) of the 2-(2'-hydroxyphenyl)-benzotriazoles includes for example 2-(2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)phenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chlorobenzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octyloxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)-benzotriazole, 2-(3',5'-bis-(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl)ethyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonyl]ethyl)-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl)ethyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl)ethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl)ethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonyl]ethyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole and 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxy-carbonyl)ethyl)phenyl)benzotriazole, 2,2'-methylenebis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazol-2-yl]phenol]; the product of esterifying 2-[3'-tert-butyl-5'-(2-methoxycarbonyl)ethyl)-2'-hydroxyphenyl]-2H-benzotriazole with polyethylene glycol 300; $[R-CH_2CH_2-COO(CH_2)_3]_2$ where $R = 3'$ -tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-ylphenyl and mixtures thereof.

- Group d) of the 2-hydroxybenzophenones includes for example 2-hydroxy-4-methoxybenzophenone, 2,2'-dihydroxy-4-methoxybenzophenone, 2,4-dihydroxybenzophenone, 2,2',4,4'-tetrahydroxybenzophenone, 2,2'-dihydroxy-4,4'-dimethoxybenzophenone, 2,2-dihydroxy-4,4-dimethoxybenzophenone, 2-hydroxy-4-(2-ethylhexyloxy)benzophenone, 2-hydroxy-4-(n-octyloxy)benzophenone, 2-hydroxy-4-methoxy-4'-methylbenzophenone, 2-hydroxy-3-carboxybenzophenone, 2-hydroxy-4-methoxybenzophenone-5-sulfonic acid and its sodium salt, and 2,2'-dihydroxy-4,4'-dimethoxybenzophenone-5,5'-bissulfonic acid and its sodium salt.
- 10 Group e) of the diphenylcyanoacrylates includes for example ethyl α -cyano- β,β -diphenylacrylate, obtainable commercially for example under the name Uvinul® 3035 from BASF AG, Ludwigshafen, 2-ethylhexyl α -cyano- β,β -diphenylacrylate, obtainable commercially for example as Uvinul® 3039 from BASF AG, Ludwigshafen, and
- 15 1,3-bis[(2'-cyano-3',3'-diphenylacryloyl)oxy]-2,2-bis{[2'-cyano-3',3'-diphenylacryloyl)oxy]methyl}propane, obtainable commercially for example under the name Uvinul® 3030 from BASF AG, Ludwigshafen.

- Group f) of the oxamides includes for example 4,4'-dioctyloxyoxanilide, 2,2'-diethoxyoxanilide, 2,2'-dioctyloxy-5,5'-di-tert-butoxanilide, 2,2'-didodecyloxy-5,5'-di-tert-butoxanilide, 2-ethoxy-2'-ethyloxanilide, N,N'-bis(3-dimethylaminopropyl)oxamide, 2-ethoxy-5-tert-butyl-2'-ethoxanilide and its mixture with 2-ethoxy-2'-ethyl-5,4'-di-tert-butoxyarylde, and also mixtures of ortho-, para-methoxy-disubstituted oxanilides and mixtures of ortho- and para-ethoxy-disubstituted oxanilides.
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- 25 Group g) of the 2-(2-hydroxyphenyl)-1,3,5-triazines includes for example 2,4,6-tris(2-hydroxy-4-octyloxyphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2,4-dihydroxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-tridecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-butyloxypropoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxypropoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[4-(dodecyloxy/tridecyloxy-2-hydroxypropoxy)-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-dodecyloxypropoxy)phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-hexyloxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-methoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2,4,6-tris[2-hydroxy-4-(3-butoxy-2-hydroxypropoxy)phenyl]-1,3,5-triazine, and 2-(2-hydroxyphenyl)-4-(4-methoxyphenyl)-6-phenyl-1,3,5-triazine.
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Group h) of the antioxidants comprises, for example:

- h.1) Alkylated monophenols such as, for example, 2,6-di-tert-butyl-4-methylphenol, 2-tert-butyl-4,6-dimethylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,6-di-tert-butyl-4-n-butylphenol, 2,6-di-tert-butyl-4-isobutylphenol, 2,6-dicyclopentyl-4-methylphenol, 2-(α -methylcyclohexyl)-4,6-dimethylphenol, 2,6-dioctadecyl-4-methylphenol, 2,4,6-tricyclohexylphenol, 2,6-di-tert-butyl-4-methoxymethylphenol,
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unbranched or sidechain-branched nonylphenols such as, for example, 2,6-dinonyl-4-methylphenol, 2,4-dimethyl-6-(1-methylundec-1-yl)phenol, 2,4-dimethyl-6-(1-methylheptadec-1-yl)phenol, 2,4-dimethyl-6-(1-methyltridec-1-yl)phenol, and mixtures thereof.

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- h.2) Alkylthiomethylphenols such as, for example, 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol and 2,6-didodecylthiomethyl-4-nonylphenol.
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- h.3) Hydroquinones and alkylated hydroquinones such as, for example, 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butylhydroquinone, 2,5-di-tert-amylhydroquinone, 2,6-diphenyl-4-octadecyloxyphenol, 2,6-di-tert-butylhydroquinone, 2,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyphenyl stearate, and bis-(3,5-di-tert-butyl-4-hydroxyphenyl) adipate.
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- h.4) Tocopherols, such as, for example, α -tocopherol, β -tocopherol, γ -tocopherol, δ -tocopherol, and mixtures thereof (vitamin E).
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- h.5) Hydroxylated thiodiphenyl ether such as, for example, 2,2'-thiobis(6-tert-butyl-4-methylphenol), 2,2'-thiobis(4-octylphenol), 4,4'-thiobis(6-tert-butyl-3-methylphenol), 4,4'-thiobis(6-tert-butyl-2-methylphenol), 4,4'-thiobis(3,6-di-sec-amylphenol), and 4,4'-bis(2,6-dimethyl-4-hydroxyphenyl) disulfide.
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- h.6) Alkylidenebisphenols such as, for example, 2,2'-methylenebis(6-tert-butyl-4-methylphenol), 2,2'-methylenebis(6-tert-butyl-4-ethylphenol), 2,2'-methylenebis[4-methyl-6-(α -methylcyclohexyl)phenol], 2,2'-methylenebis(4-methyl-6-cyclohexylphenol), 2,2'-methylenebis(6-nonyl-4-methylphenol), 2,2'-methylenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(4,6-di-tert-butylphenol),
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- 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol), 2,2'-methylenebis[6-(α -methylbenzyl)-4-nonylphenol], 2,2'-methylenebis[6-(α,α -dimethylbenzyl)-4-nonylphenol], 4,4'-methylenebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-2-methylphenol), 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-
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- 3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis(3-tert-butyl-4-hydroxyphenyl)butyrate], bis(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2-hydroxy-5-methylbenzyl)-6-tert-butyl-4-methylphenyl] terephthalate, 1,1-bis(3, 5-dimethyl-2-
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- hydroxyphenyl)butane, 2,2-bis(3,5-di-tert-butyl-4-hydroxyphenyl)propane, 2,2-bis-(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1,1,5,5-tetra-(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.
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- h.7) Benzyl compounds such as, for example, 3,5,3',5'-tetra-tert-butyl-4,4'-dihydroxydibenzyl ether, octadecyl 4-hydroxy-3,5-dimethylbenzylmercaptoacetate, tridecyl 4-hydroxy-3,5-di-tert-

- butylbenzylmercaptoacetate, tris(3,5-di-tert-butyl-4-hydroxybenzyl)amine, 1,3,5-tri(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, di(3,5-di-tert-butyl-4-hydroxybenzyl) sulfide, isooctyl 3,5-di-tert-butyl-4-hydroxybenzylmercaptoacetate, bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithiol terephthalate, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl) isocyanurate, 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl) isocyanurate, 3,5-di-tert-butyl-4-hydroxybenzyl-phosphoric acid dioctadecyl ester, and 3,5-di-tert-butyl-4-hydroxybenzyl-phosphoric acid monoethyl ester, calcium salt.
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- 10 h.8) Hydroxybenzylated malonates such as, for example, dioctadecyl 2,2-bis(3,5-di-tert-butyl-2-hydroxybenzyl)malonate, dioctadecyl-2-(3-tert-butyl-4-hydroxy-5-methylbenzyl)malonate, didodecyl mercaptoethyl-2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate, and bis[4-(1,1,3,3-tetramethylbutyl)phenyl] 2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate.
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- h.9) Hydroxybenzyl aromatics such as, for example, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, 1,4-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-2,3,5,6-tetramethylbenzene, and 2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)phenol.
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- h.10) Triazine compounds such as, for example, 2,4-bis(octylmercapto)-6-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,3,5-triazine, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,2,3-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl) isocyanurate, 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl) isocyanurate, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenylethyl)-1,3,5-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexahydro-1,3,5-triazine, and 1,3,5-tris(3,5-dicyclohexyl-4-hydroxybenzyl) isocyanurate.
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- h.11) Benzylphosphonates such as, for example, dimethyl 2,5-di-tert-butyl-4-hydroxybenzylphosphonate, diethyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl 5-tert-butyl-4-hydroxy-3-methylbenzylphosphonate, and the calcium salt of monoethyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate.
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- h.12) Acylaminophenols such as, for example, 4-hydroxylauranilide, 4-hydroxystearanilide, 2,4-bis(octylmercapto)-6-(3,5-tert-butyl-4-hydroxyanilino)-s-triazine, and octyl N-(3,5-di-tert-butyl-4-hydroxyphenyl)carbamate.
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- h.13) Esters of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with monohydric or polyhydric alcohols, such as with methanol, ethanol, n-octanol, isooctanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxalamide,
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3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, and 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

- 5 h.14) Esters of β -(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with monohydric or polyhydric alcohols, such as with methanol, ethanol, n-octanol, isooctanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, and 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.
- 15 h.15) Esters of β -(3,5-dicyclohexyl-4-hydroxyphenyl)propionic acid with monohydric or polyhydric alcohols, such as with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, and 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.
- 20 h.16) Esters of 3,5-di-tert-butyl-4-hydroxyphenylacetic acid with monohydric or polyhydric alcohols, such as with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, and 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.
- 30 h.17) Amides of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid, such as N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexamethylenediamide, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamide, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazide, N,N'-bis[2-(3-[3,5-di-tert-butyl-4-hydroxyphenyl]propionyloxy)ethyl]oxamide (e.g. Naugard®XL-1 from Uniroyal).
- 35 h.18) Ascorbic acid (vitamin C)
- 40 h.19) Amine antioxidants, such as, for example, N,N'-diisopropyl-p-phenylenediamine, N,N'-di-sec-butyl-p-phenylenediamine, N,N'-bis(1,4-dimethylpentyl)-p-phenylenediamine, N,N'-bis(1-ethyl-3-methylpentyl)-p-phenylenediamine, N,N'-bis(1-methylheptyl)-p-phenylenediamine, N,N'-dicyclohexyl-p-phenylenediamine, N,N'-diphenyl-p-phenylenediamine, N,N'-bis(2-naphthyl)-p-phenylenediamine, N-isopropyl-N'-phenyl-p-phenylenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine, N-(1-methylheptyl)-N'-phenyl-p-phenylenediamine, N-cyclohexyl-N'-phenyl-p-phenylenediamine, 4-(p-toluenesulfamoyl)diphenylamine, N,N'-dimethyl-N,N'-di-sec-butyl-p-phenylenediamine, diphenylamine, N-allyldiphenylamine, 4-isopropoxydiphenylamine, N-phenyl-1-naphthylamine, N-(4-tert-octylphenyl)-1-

- naphthylamine, N-phenyl-2-naphthylamine, octylated diphenylamine, for example, p,p'-di-tert-octyldiphenylamine, 4-n-butylaminophenol, 4-butyrylaminophenol, 4-nonanoylaminophenol, 4-dodecanoylaminophenol, 4-octadecanoylaminophenol, bis(4-methoxyphenyl)amine, 2,6-di-tert-butyl-4-dimethylaminomethylphenol, 2,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylmethane, N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane, 1,2-bis[(2-methylphenyl)amino]ethane, 1,2-bis(phenylamino)propane, o-tolyl biguanide, bis[4-(1',3'-dimethylbutyl)-phenyl]amine, tert-octylated N-phenyl-1-naphthylamine, a mixture of mono- and dialkylated tert-butyl/tert-octyldiphenylamines, a mixture of mono- and dialkylated nonyldiphenylamines, a mixture of mono- and dialkylated dodecyldiphenylamines, a mixture of mono- and dialkylated isopropyl/isohexyldiphenylamines, mixtures of mono- and dialkylated tert-butyldiphenylamines, 2,3-dihydro-3,3-dimethyl-4H-1,4-benzothiazine, phenothiazine, a mixture of mono- and dialkylated tert-butyl/tert-octylphenothiazines, a mixture of mono- and dialkylated tert-octylphenothiazines, N-allylphenothiazine, N,N,N',N'-tetraphenyl-1,4-diaminobut-2-ene, N,N-bis(2,2,6,6-tetramethylpiperid-4-yl)hexamethylenediamine, bis(2,2,6,6-tetramethylpiperid-4-yl) sebacate, 2,2,6,6-tetramethylpiperidin-4-one, 2,2,6,6-tetramethylpiperidin-4-ol.
- Group i) of the nickel compounds includes for example nickel complexes of 2,2'-thiobis[4-(1,1,3,3-tetramethylbutyl)phenol], such as the 1:1 or 1:2 complex, with or without additional ligands such as n-butylamine, triethanolamine or N-cyclohexyldiethanolamine, nickel dibutyl dithiocarbamate, nickel salts of 4-hydroxy-3,5-di-tert-butylbenzylphosphonic acid monoalkyl esters such as of the methyl or ethyl esters, for example, nickel complexes of ketoximes, for example of 2-hydroxy-4-methylphenyl undecyl ketoxime, and the nickel complex of 1-phenyl-4-lauroyl-5-hydroxypyrazole, with or without additional ligands.
- Group j) of the sterically hindered amines includes for example 4-hydroxy-2,2,6,6-tetramethylpiperidine, 1-allyl-4-hydroxy-2,2,6,6-tetramethylpiperidine, 1-benzyl-4-hydroxy-2,2,6,6-tetramethylpiperidine, bis(2,2,6,6-tetramethyl-4-piperidyl) sebacate, bis(2,2,6,6-tetramethyl-4-piperidyl) succinate, bis(1,2,2,6,6-pentamethyl-4-piperidyl) sebacate, bis(1-octyloxy-2,2,6,6-tetramethyl-4-piperidyl) sebacate, bis(1,2,2,6,6-pentamethyl-4-piperidyl) n-butyl-3,5-di-tert-butyl-4-hydroxybenzylmalonate, condensation product of 1-(2-hydroxyethyl)-2,2,6,6-tetramethyl-4-hydroxypiperidine and succinic acid, linear or cyclic condensation products of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-tert-octylamino-2,6-dichloro-1,3,5-triazine, tris(2,2,6,6-tetramethyl-4-piperidyl) nitrilotriacetate, tetrakis(2,2,6,6-tetramethyl-4-piperidyl) 1,2,3,4-butanetetracarboxylate, 1,1'-(1,2-ethanediyl)bis(3,3,5,5-tetramethylpiperazinone), 4-benzoyl-2,2,6,6-tetramethylpiperidine, 4-stearyloxy-2,2,6,6-tetramethylpiperidine, bis(1,2,2,6,6-pentamethylpiperidyl) 2-n-butyl-2-(2-hydroxy-3,5-di-tert-butylbenzyl)malonate, 3-n-octyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl) sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl) succinate, linear or cyclic condensation products of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-morpholino-2,6-dichloro-1,3,5-triazine, condensation product of 2-chloro-4,6-bis(4-n-butylamino-

2,2,6,6-tetramethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, condensation product of 2-chloro-4,6-di-(4-n-butylamino-1,2,2,6,6-pentamethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, 8-acetyl-3-dodecyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, 3-dodecyl-1-(2,2,6,6-tetramethyl-4-piperidyl)pyrrolidine-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione, mixture of 4-hexadecyloxy- and 4-stearyloxy-2,2,6,6-tetramethylpiperidine, condensation product of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-cyclohexylamino-2,6-dichloro-1,3,5-triazine, condensation product of 1,2-bis(3-aminopropylamino)ethane and 2,4,6-trichloro-1,3,5-triazine and also 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [136504-96-6]); N-(2,2,6,6-tetramethyl-4-piperidyl)-n-dodecylsuccinimide, N-(1,2,2,6,6-pentamethyl-4-piperidyl)-n-dodecylsuccinimide, 2-undecyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxospiro[4.5]decane, reaction product of 7,7,9,9-tetramethyl-2-cycloundecyl-1-oxa-3,8-diaza-4-oxospiro[4.5]decane and epichlorohydrin, 1,1-bis(1,2,2,6,6-pentamethyl-4-piperidyl)oxycarbonyl-2-(4-methoxyphenyl)ethene, N,N'-bisformyl-N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine, diester of 4-methoxymethylenemalononic acid with 1,2,2,6,6-pentamethyl-4-hydroxypiperidine, poly[methylpropyl-3-oxo-4-(2,2,6,6-tetramethyl-4-piperidyl)]siloxane, reaction product of maleic anhydride- α -olefin copolymer and 2,2,6,6-tetramethyl-4-aminopiperidine or 1,2,2,6,6-pentamethyl-4-aminopiperidine, copolymers of (partially) N-piperidin-4-yl-substituted maleimide and a mixture of α -olefins such as Uvinul® 5050H (BASF AG), 1-(2-hydroxy-2-methylpropoxy)-4-octadecanoyloxy-2,2,6,6-tetramethylpiperidine, 1-(2-hydroxy-2-methylpropoxy)-4-hexadecanoyloxy-2,2,6,6-tetramethylpiperidine, the reaction product of 1-oxyl-4-hydroxy-2,2,6,6-tetramethylpiperidine and a carbon radical of t-amyl alcohol, 1-(2-hydroxy-2-methylpropoxy)-4-hydroxy-2,2,6,6-tetramethylpiperidine, 1-(2-hydroxy-2-methylpropoxy)-4-oxo-2,2,6,6-tetramethylpiperidine, bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) sebacate, bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) adipate, bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) succinate, bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) glutarate, 2,4-bis{N[1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl]-N-butylamino}-6-(2-hydroxyethylamino)-s-triazine, N,N'-bisformyl-N,N'-bis(1,2,2,6,6-pentamethyl-4-piperidyl)hexamethylenediamine, hexahydro-2,6-bis(2,2,6,6-tetramethyl-4-piperidyl)-1H,4H,5H,8H-2,3a,4a,6,7a,8a-hexaazacyclopenta[def]fluorene-4,8-dione (e.g. Uvinul® 4049 from BASF AG, Ludwigshafen).

Group k) of the metal deactivators includes for example N,N'-diphenyloxalamide, N-salicylal-N'-salicyloylhydrazine, N,N'-bis(salicyloyl)hydrazine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazine, 3-salicyloylamino-1,2,4-triazole, bis(benzylidene)oxalyl dihydrazide, oxanilide, isophthaloyl dihydrazide, sebacoylbisphenyl hydrazide, N,N'-diacetyl adipic dihydrazide, N,N'-bis(salicyloyl)oxalic dihydrazide, and N,N'-bis(salicyloyl)thiopropionyl dihydrazide.

Group l) of the phosphites and phosphonites includes for example triphenyl phosphite, diphenyl alkyl phosphite, phenyl dialkyl phosphite, tris(nonylphenyl) phosphite, triauryl phosphite, trioctadecyl phosphite, distearyl pentaerythritol diphosphite, tris(2,4-di-tert-

butylphenyl) phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl) pentaerythritol diphosphite, bis(2,6-di-tert-butyl-4-methylphenyl) pentaerythritol diphosphite, diisodecyloxy pentaerythritol diphosphite, bis(2,4-di-tert-butyl-6-methylphenyl) pentaerythritol diphosphite, bis(2,4,6-tris(tert-butylphenyl) pentaerythritol diphosphite, tristearyl sorbitol triphosphite, tetrakis(2,4-di-tert-butylphenyl) 4,4'-biphenylenediphosphonite, 6-isooctyloxy-2,4,8,10-tetra-tert-butyl-dibenzo[d,f][1,3,2]dioxaphosphine, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenzo[d,g][1,3,2]dioxaphosphocine, bis(2,4-di-tert-butyl-6-methylphenyl) methyl phosphite, bis(2,4-di-tert-butyl-6-methylphenyl) ethyl phosphite, 2,2',2''-nitrilo[triethyl tris(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite], 2-ethylhexyl 3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl phosphite, tris(2,4-di-tert-butylphenyl) phosphite (Irgafos® 168, Ciba), tris(nonylphenyl) phosphite.

Group m) of the hydroxylamines includes for example N, N-dibenzylhydroxylamine, N,N-diethylhydroxylamine, N,N-dioctylhydroxylamine, N,N-dilaurylhydroxylamine, N,N-ditetradecylhydroxylamine, N,N-dihexadecylhydroxylamine, N,N-dioctadecylhydroxylamine, N-hexadecyl-N-octadecylhydroxylamine, N-heptadecyl-N-octadecylhydroxylamine, N-methyl-N-octadecylhydroxylamine, and N,N-dialkylhydroxylamine from hydrogenated tallow fatty amines.

Group n) of the nitrones includes for example N-benzyl α -phenyl nitrone, N-ethyl α -methyl nitrone, N-octyl α -heptyl nitrone, N-lauryl α -undecyl nitrone, N-tetradecyl α -tridecyl nitrone, N-hexadecyl α -pentadecyl nitrone, N-octadecyl α -heptadecyl nitrone, N-hexadecyl α -heptadecyl nitrone, N-octadecyl α -pentadecyl nitrone, N-heptadecyl α -heptadecyl nitrone, N-octadecyl α -hexadecyl nitrone, N-methyl α -heptadecyl nitrone, and nitrones derived from N,N-dialkylhydroxylamines prepared from hydrogenated tallow fatty amines.

Group o) of the amine oxides includes for example amine oxide derivatives as described in U.S. Patent Nos. 5,844,029 and 5,880,191, didecylmethylamine oxide, tridecylamine oxide, tridodecylamine oxide and trihexadecylamine oxide.

Group p) of the benzofuranones and indolinones includes for example those described in US patents 4,325,863, 4,338,244, 5,175,312, 5,216,052, 5,252,643; in DE-A-4316611, in DE-A-4316622; in DE-A-4316876; in EP-A-0589839 or EP-A-0591102, or 3-[4-(2-acetoxyethoxy)phenyl]-5,7-di-tert-butylbenzofuran-2-one, 5,7-di-tert-butyl-3-[4-(2-stearoyloxyethoxy)phenyl]benzofuran-2-one, 3,3'-bis[5,7-di-tert-butyl-3-(4-[2-hydroxyethoxy]phenyl)]benzofuran-2-one], 5,7-di-tert-butyl-3-(4-ethoxyphenyl)benzofuran-2-one, 3-(4-acetoxy-3,5-dimethylphenyl)-5,7-di-tert-butylbenzofuran-2-one, 3-(3,5-dimethyl-4-pivaloyloxyphenyl)-5,7-di-tert-butylbenzofuran-2-one, 3-(3,4-dimethylphenyl)-5,7-di-tert-butylbenzofuran-2-one, Irganoxs HP-136 from Ciba Specialty Chemicals, and 3-(2,3-dimethylphenyl)-5,7-di-tert-butylbenzofuran-2-one.

Group q) of the thiosynergists includes for example dilauryl thiodipropionate or distearyl thiodipropionate.

Group r) of the peroxide-destroying compounds includes for example esters of β -thiodipropionic acid, for example, the lauryl, stearyl, myristyl or tridecyl ester, mercap-
tobenzimidazole or the zinc salt of 2-mercaptobenzimidazole, zinc dibutyldithiocar-
bamate, dioctadecyl disulfide, and pentaerythritol tetrakis(β -
5 dodecylmercapto)propionate.

Group s) of the basic costabilizers includes for example melamine, polyvinylpyrrolidone, dicyandiamide, triallylcyanurate, urea derivatives, hydrazine derivatives, amines,
10 polyamides, polyurethanes, alkali metal and alkaline earth metal salts of higher fatty acids, for example, calcium stearate, zinc stearate, magnesium behenate, magnesium stearate, sodium ricinoleate, and potassium palmitate, antimony pyrocatecholate or zinc pyrocatecholate.

15 One preferred embodiment of the present invention uses at least one compound I together with at least one further light stabilizer having at least one absorption maximum in the wavelength range from 280 to 400 nm. The further light stabilizer is preferably selected from compounds of groups b), c), d), e), and g).

20 The light stabilizer in question in particular has at least one absorption maximum in the wavelength range from 280 to 320 nm. Accordingly, the light stabilizer employed additionally has at least one absorption maximum in the UVB range. Absorption maxima for the purposes of the present invention are the bands associated with the corresponding
25 local or absolute maxima in the UV spectrum of the respective compounds, as measured in common organic solvents such as dichloromethane, acetonitrile or methanol at room temperature. The extinction of the UVB absorbers at the maximum, which is measured in solution, normally in dichloromethane, at a concentration of 1% by weight and a path length of 1 cm, is at least 100, in particular at least 200.

30 Examples of light stabilizers used additionally in particular are the aforementioned diphenylcyanoacrylates of group e).

In another preferred embodiment of the present invention at least one naphthalene-1,8-dicarboxylic monoimide I is used as sole light stabilizer from the group of the naphthalene derivatives having at least one absorption maximum in the wavelength range
35 above 320 to 400 nm. Typical representatives from the group of the naphthalene derivatives are the naphthalene-1,8-dicarboxylic monoimides I used in accordance with the invention and also naphthalenedicarboxylic acids, naphthalenedicarboxylic esters, naphthalenedicarboxylic anhydrides, naphthalenetetracarboxylic acids, naphthalenetetracarboxylic anhydrides, and naphthalenetetracarboxylic esters.
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The plastic may further comprise other additives. Suitable additives from the group t) are the customary additives, such as pigments, dyes, nucleating agents, fillers, reinforcing agents, antistats, antifogging agents, biocides, and antistats, for example.

Suitable pigments are for example titanium dioxide in its three modifications - rutile, anatase or brookite, phthalocyanines, ultramarine blue, iron oxides or carbon black, and also the class of the organic pigments.

- 5 By dyes are meant all colorants which can be used for the transparent, semi-transparent or non-transparent coloring of polymers. Likewise regarded as dyes are compounds which exhibit a fluorescence or phosphorescence in the visible part of the electromagnetic spectrum, such as fluorescent dyes and phosphorescent dyes.
- 10 Suitable nucleating agents include for example inorganyl substances, examples being talc, metal oxides such as titanium dioxide or magnesium oxide, phosphates, carbonates or sulfates, preferably of alkaline earth metals; orgaryl compounds such as mono-carboxylic or polycarboxylic acids and also their salts, such as 4-tert-butylbenzoic acid, adipic acid, diphenylacetic acid, sodium succinate or sodium benzoate; and polymeric
- 15 compounds, such as ionic copolymers ("ionomers"), for example.

- Suitable fillers and reinforcing agents include for example calcium carbonate, silicates, talc, mica, kaolin, barium sulfate, metal oxides and metal hydroxides, carbon black, graphite, wood flour and flours or fibers of other natural products, and synthetic fibers.
- 20 Further suitable examples of fibrous or pulverulent fillers include carbon or glass fibers in the form of glass fabrics, glass mats or filament glass rovings, chopped glass, glass beads, and wollastonite. Glass fibers can be incorporated either in the form of short glass fibers or in the form of continuous fibers (rovings).
- 25 Examples of suitable antistats include amine derivatives such as N,N-bis(hydroxy-alkyl)alkylamines or -alkylenamines, polyethylene glycol esters and ethers, ethoxylated carboxylic esters and carboxamides, and glyceryl mono- and distearates, and also mixtures thereof.
- 30 Normally the plastic is admixed with at least one naphthalene-1,8-dicarboxylic monoimide I in an amount of from 0.01 to 10% by weight, preferably from 0.01 to 5% by weight, and more preferably from 0.01 to 1.0% by weight, based on the total weight of the plastic. By the total weight of the plastic is meant the weight of the plastic additized with the naphthalene-1,8-dicarboxylic monoimide I and, where appropriate, with further stabiliz-
- 35 ers (plastic + sum of all stabilizers + sum of all other additives).

The compounds from groups a) to s), with the exception of the benzofuranones of group p), are used in customary amounts: for example, in amounts of from 0.0001 to 10% by weight, preferably from 0.01 to 1% by weight, based on the total weight of the

40 plastic.

The additives of group t) are used in the customary amounts. They are normally used in an amount of from 0 to 60% by weight, based on the total weight of the plastic.

- 45 The naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention can also be added in the form of a premix (masterbatch) containing at least one naph-

thalene-1,8-dicarboxylic monoimide I in a concentration of from 1 to 20% by weight to the materials that are to be stabilized, usually a plastic. The premix may further comprise the aforementioned compounds of groups a) to s) and other additives of group t).

- 5 The present invention further provides a process for protecting inanimate organic material against ultraviolet radiation, which involves producing the packaging using a plastic comprising at least one naphthalene-1,8-dicarboxylic monoimide I.

10 The naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention and, where present, the compounds of groups a) to s) and/or the other additives of group t) are added to the plastic. Addition is made in a customary way, by blending with the plastic, for example. Thus the naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention and, where appropriate, the further stabilizers may also be added to the starting monomers, and the mixture of monomers and stabilizers can
15 be polymerized. It is also possible to add the naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention and, where appropriate, the compounds of groups a) to s) and/or the other additives of group t) to the monomers during the polymerization. A precondition for addition before or during polymerization is that the naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention and,
20 where appropriate, the compounds of groups a) to s) and/or the other additives of group t) are stable under the polymerization conditions: that is, that they exhibit little or no decomposition.

It is preferred to add the naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention and, where present, the compounds of groups a) to s) and/or the other additives of group t) to the finished plastic. This is effected in a usual fashion by mixing methods which are known per se: for example, with melting at temperatures from 150 to 300°C. However, the components can also be mixed "cold", without melting, and the powderous or granular mixture is not melted and homogenized until during
30 processing.

It will be appreciated that the naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention and, where present, the compounds of groups a) to s) and/or the other additives of group t) can be added together or separately from one another,
35 all at once, in portions, or continuously, at a constant rate or along a gradient. For example, part of the naphthalene-1,8-dicarboxylic monoimide used in accordance with the invention can be added to the monomers during the actual polymerization, and the remainder can be added only to the finished polymer, or all of the naphthalene-1,8-dicarboxylic monoimide can be added to the finished polymer.

40 Blending takes place preferably in a customary extruder, with the components being able to be introduced into the extruder as a mixture or individually, completely for example, by way of a hopper or else introduced proportionally at a later point in the extruder to the melt or solid product in the extruder. For melt extrusion particular suitability is possessed by, for example, single-screw or twin-screw extruders. A twin-screw
45 extruder is preferred.

The mixtures obtained can be pelletized or granulated, for example, or processed by methods which are common knowledge: for example, by extrusion, injection molding, foaming with blowing agents, thermoforming, hollow body blowing or calendering.

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The plastics can preferably be used to produce moldings (including semifinished products, films, sheets, and foams) of all kinds, examples being packaging and films, for textiles for example, particularly packaging for cosmetics, perfumes, and pharmaceutical products, and packaging and films for foods, beverage bottles, or packaging for cleaning products. It is also possible to produce stretch films from thermoplastic molding compounds.

10

Any product may in principle be protected by a packaging which comprises the naphthalene-1,8-dicarboxylic monoimide used in accordance with the invention. The product to be protected is preferably selected from cosmetics, drugs, perfumes, foods, and cleaning products. Suitable cosmetics include soap, body lotion, skin cream, shower gel, bubble bath, body spray, makeup, eyeliner, mascara, rouge, lipstick, shampoo, hair conditioner, hair gel, hair wax, hair lotion, nail varnish, nail varnish remover, etc. Suitable pharmaceutical products include pharmaceutical compositions or drugs in the form of tablets, pills, film-coated tablets, suppositories, solutions, concentrates, suspensions, and the like. Suitable foodstuffs include carbonated and noncarbonated beverages, examples being carbonated beverages such as lemonade, beer, carbonated fruit juice drinks, carbonated water, noncarbonated beverages such as wine, fruit juice, tea or coffee, fruit, meat, sausage, dairy products such as milk, yogurt, butter or cheese, animal and vegetable fats, bakery products, pasta, seasonings, sauces, pastes, pestos, stocks, purees, ketchups, dressings, etc. Suitable cleaning products include household cleaners and industrial cleaners.

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The naphthalene-1,8-dicarboxylic monoimide I to be employed in accordance with the invention is used with particular preference in thermoplastic molding compounds comprising polyolefins for agricultural films and packaging films, in biaxially oriented polypropylene for stretch-wrap films, in polyethylene terephthalate or polyethylene naphthalate for bottles and other container packs, in polyvinyl butyral for laminated glass, in polystyrene for blister packs and other packaging containers, in polycarbonate for bottles, flasks and other packaging containers and moldings, in polyvinyl chloride for packaging containers and films, or in polyvinyl alcohol for producing films.

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Where appropriate, the films of different polymers can be combined with one another by lamination or in the form of extrusion laminates to form composite films. By monoaxial or biaxial stretching it is possible where appropriate to improve the properties. This is utilized, for example, in order to produce shrink films. Shrink films can be produced from polyethylene terephthalate, polyethylene, polyvinylidene chloride or polyvinyl chloride, for example.

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The materials stabilized using at least one naphthalene-1,8-dicarboxylic monoimide I exhibit particular quality features in comparison to unstabilized materials and to materi-

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als stabilized with prior art stabilizers. The materials stabilized in accordance with the invention feature an extended exposure time, since light-induced damage does not begin until later. Moreover, the material stabilized using at least one naphthalene-1,8-dicarboxylic monoimide protects not only the material to be stabilized but also the packaged contents.

Embodiment example

The examples below are intended to illustrate the invention, though without restricting it.

I. Preparation examples

Example 1: Preparation of 4-cyano-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide (compound I-A.1)

1.1 Preparation of 4-bromo-*N*-(2,6-diisopropylphenyl)-naphthalene-1,8-dicarboximide

27.7 g of 4-bromonaphthalene-1,8-dicarboxylic anhydride, 19.0 g of 2,6-diisopropylaniline and 9.2 g of anhydrous zinc acetate in 65 ml of *N*-methylpyrrolidone were heated at 200°C for 3 hours. After cooling, the precipitate formed was filtered off, washed and dried to give 26.2 g of 4-bromo-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide having a melting point of 277°C.

1.2 Preparation of 4-cyano-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide

24.8 g of 4-bromo-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide and 7.5 g of copper(I) cyanide in 150 ml of *N*-methylpyrrolidone were heated at 210°C for 4 hours.

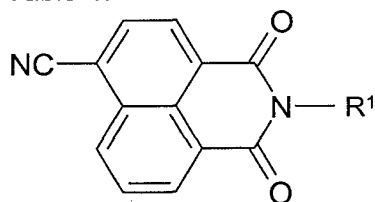
After cooling, water was added to the reaction mixture, producing a precipitate. The precipitate was filtered off, washed and dried. Column chromatography of the precipitate on silica gel (eluent: dichloromethane) gave 15.6 g of 4-cyano-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide having a melting point of 291°C.

Elemental analysis: C₂₅H₂₂N₂O₂ (382.5 g/mol): calc.: C 78.5; H 5.8; N 7.3; O 8.4. found.: C 78.5; H 5.9; N 7.0; O 8.4;

UV (dichloromethane): λ_{\max} (lg ϵ) 352 nm (4.16).

Following the method described in Example 1, in Examples 2 to 5 the 4-cyano-substituted naphthalene-1,8-dicarboxylic monoimides I-A.2 to I-A.5 were prepared. The melting points and spectroscopic properties of the 4-cyano-substituted naphthalene-1,8-dicarboxylic monoimides I-A.1 to I-A.5 are summarized in Table 1. Dichloromethane was used as solvent for the UV spectroscopy.

Table 1:



(I-A)

Example	R ¹	Compound	m.p. [°C]	λ_{\max} [nm]	lg ϵ
1	2,6-diisopropylphenyl	I-A.1	291	352	4.16
2	Cyclohexyl	I-A.2	258	354	4.10
3	4- <i>tert</i> -butylcyclohexyl (cis and trans)	I-A.3	213	354	4.05
4	Phenyl	I-A.4	>300	354	4.15
5	2,4,6-trimethylphenyl	I-A.5	305	352	4.17

- 5 Example 6: Preparation of 4-aminocarbonyl-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide (compound I-B.1)

8 g of 4-cyano-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide from Example 1 in 130 ml of concentrated sulfuric acid were heated at 80°C for 3 hours. The reaction mixture was subsequently poured into ice-water and the precipitate formed was filtered off, washed and dried. This gave 5.1 g of 4-aminocarbonyl-*N*-(2,6-diisopropylphenyl)-naphthalene-1,8-dicarboximide having a melting point of 233°C.

UV (dichloromethane): λ_{\max} (lg ϵ): 336 nm (4.18).

- 15 Example 7: Preparation of *N*-(2,6-diisopropylphenyl)-4-(4-*tert*-octylphenoxy)-naphthalene-1,8-dicarboximide (compound I-C.1)

7.1 Preparation of 4-chloro-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide

20 A mixture of 23.3 g of 4-chloronaphthalene-1,8-dicarboxylic anhydride, 19.0 g of 2,6-diisopropylaniline and 9.2 g of anhydrous zinc acetate in 65 ml of *N*-methylpyrrolidone was heated at 200°C for 3 hours. After cooling, the precipitate formed was filtered off, washed and dried. This gave 22.4 g of 4-chloro-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide having a melting point of 289°C.

7.2 Preparation of *N*-(2,6-diisopropylphenyl)-4-(4-*tert*-octylphenoxy)naphthalene-1,8-dicarboximide

30 A mixture of 5.0 g of 4-chloro-*N*-(2,6-diisopropylphenyl)naphthalene-1,8-dicarboximide from 7.1, 3.5 g of 4-(1,1,3,3-tetramethylbutyl)phenol (*tert*-octylphenol) and 1.2 g of potassium carbonate in 60 ml of *N*-methylpyrrolidone was heated at 80°C for 24 hours. It was cooled and methanol and water were added to the reaction mixture, producing a

precipitate. The precipitate thus obtained was filtered off, washed and dried to give 6.2 g of *N*-(2,6-diisopropylphenyl)-4-(4-*tert*-octylphenoxy)naphthalene-1,8-dicarboximide having a melting point of 217°C.

5 ¹H-NMR (DMSO-d₆): δ [ppm]: 0.78 (s, 9 H), 1.12 (t, J = 7.3 Hz, 6 H), 1.42 (s, 6 H), 1.80 (s, 2 H), 2.75 (sept, J = 6.8 Hz, 2 H), 6.93 (d, J = 8.5 Hz, 1 H), 7.15 (d, J = 8.5 Hz, 2 H), 7.32 (d, J = 7.5 Hz, 2 H), 7.48 (t, J = 7.5 Hz, 1 H), 7.52 (d, J = 9.0 Hz, 2 H), 7.82 (dd, J = 8.0, 7.0 Hz, 1 H), 8.48 (d, J = 9.5 Hz, 1 H), 8.68 (dd, J = 7.0, 1.0 Hz, 1 H), 8.80 (dd, J = 8.5, 1.5 Hz, 1 H);

10

¹³C-NMR (DMSO-d₆): δ [ppm]: 24.1 (q), 29.4 (d); 31.8 (q), 31.9 (q), 32.6 (s), 38.8 (s), 57.4 (t), 110.6 (d), 116.6 (s), 120.4 (d), 123.0 (s), 124.3 (d), 124.5 (s), 126.8 (d), 128.6 (d), 129.3 (d), 129.6 (d), 130.7 (s) 132.0 (s), 135.5 (d), 133.6 (d), 146.5 (s), 148.2 (s), 152.6 (s), 161.0 (s), 164.2 (s), 164.8 (s);

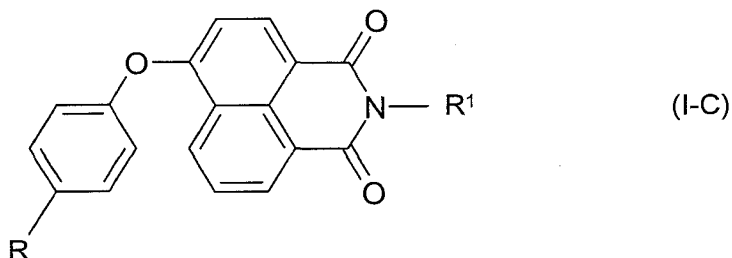
15

UV (dichloromethane): λ_{max} (lg ε) 364 nm (4.22).

Following the method described in Example 7, in Examples 8 to 16 the 4-phenoxy-substituted naphthalene-1,8-dicarboxylic monoimides I-C.2 to I-C.10 were prepared.

20 The melting points and spectroscopic properties of the 4-phenoxy-substituted naphthalene-1,8-dicarboxylic monoimides I-C.1 to I-C.10 are summarized in Table 2. Dichloromethane was used as solvent for the UV spectroscopy.

Table 2:



25

Example	R ¹	R	Compound	m.p. [°C]	λ _{max} [nm]	lg ε
7	2,6-diisopropylphenyl	<i>tert</i> -octyl	I-C.1	217	364	4.22
8	2,6-diisopropylphenyl	isopropyl	I-C.2	200	364	4.21
9	2,6-diisopropylphenyl	<i>tert</i> -pentyl	I-C.3	256	364	4.22
10	phenyl	<i>tert</i> -octyl	I-C.4	222	364	4.21
11	phenyl	isopropyl	I-C.5	193	364	4.24
12	phenyl	<i>tert</i> -pentyl	I-C.6	196	364	4.18
13	2-ethylhexyl	<i>tert</i> -octyl	I-C.7	124	364	4.19
14	2-ethylhexyl	isopropyl	I-C.8	94	362	4.20
15	2-ethylhexyl	<i>tert</i> -pentyl	I-C.9	120	364	4.15
16	2,4,6-trimethylphenyl	<i>tert</i> -octyl	I-C.10	221	364	4.22

II. Use examples

Examples 17-20: Incorporation of the UV absorbers into polyethylene terephthalate (PET) film

5

A mixture of a polyethylene terephthalate (Polyclear T94 from Ter Hell & Co GmbH, Hamburg) and the concentration of compound I stated in Table 3 was homogenized in a Berstorff twin-screw extruder (melt temperature: 275°C) and then granulated. The resultant granules were subsequently extruded in a Weber single-screw extruder through a slot die (melt temperature: 225°C) and pressed to a thickness of 300 µm via a roll takeoff.

10

The results are summarized in Table 3. The parameters reported are the wavelengths below which less than 10% or 20% of the radiation passes through the film. A value below and preferably close to 400 nm signifies that the material beneath the film is effectively protected against UV radiation.

15

Table 3:

Example	Compound	Concentration [%]	Wavelength 10% ^a [nm]	Wavelength 20% ^b [nm]
17	I-A.1	0.4	371	372
18	I-B.1	0.2	355	362
19	I-B.1	0.4	369	371
20	I-C.1	0.2	388	394
21	Without UV absorber (PET alone)		318	319

20

^a Maximum wavelength with a transmittance of 10%.

^b Maximum wavelength with a transmittance of 20%

The examples show that the naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention can be incorporated effectively into the PET films. The naphthalene-1,8-dicarboxylic monoimides I used in accordance with the invention filter the major part of the damaging UV radiation from the spectrum and are therefore suitable as effective UV filters.

25

30 Example 22: Exposure of an additized PET film

The PET film from Example 17 (containing 0.4% of compound I-A.1) was exposed for 1000 hours in accordance with DIN 54004. The transmittance profile of the film was measured at regular intervals and is shown in Table 4.

35

Table 4:

Exposure time [h]	Wavelength 10% ^a [nm]	Wavelength 20% ^b [nm]
0	371	372
200	371	372
400	371	372
600	371	372
1000	370	372

^a Maximum wavelength with a transmittance of 10%.

^b Maximum wavelength with a transmittance of 20%

5

Example 23: Exposure of an additized PET film

The PET film from Example 20 (containing 0.2% of compound I-C.1) was exposed for 1000 hours in accordance with DIN 54004. The transmittance profile of the film was measured at regular intervals and is shown in Table 5.

10

Table 5:

Exposure time [h]	Wavelength 10% ^a [nm]	Wavelength 20% ^b [nm]
0	389	394
1000	388	393

^a Maximum wavelength with a transmittance of 10%.

^b Maximum wavelength with a transmittance of 20%

15

Examples 22 and 23 show that the naphthalene-1,8-dicarboxylic monoimides I are photostable, i.e., are not broken down. Accordingly the naphthalene-1,8-dicarboxylic monoimides I are suitable long-term UV filter substances.

20 Examples 24 to 26: Production of PET moldings

Based on Examples 17 to 20, granules of PET and of compounds I were produced. Thereafter injection moldings with a thickness of 1 mm were produced in an Arburg 220M injection molding machine.

25

The yellowness indices (YI, in accordance with DIN 6167) of the injection moldings are reported in Table 6. A yellowness index of zero means that the specimen is pure white. Negative YI values mean that the specimen is bluish (the more negative YI, the bluer). Positive YI values indicate that the specimen is yellowish. The more positive the YI, the yellower the specimen appears to the viewer.

30

Table 6:

Example	UV absorber	YI
24	none	2.5
25	I-A.1	4.2
26	I-C.1	-4.1

Example 27: Protection of vitamin A

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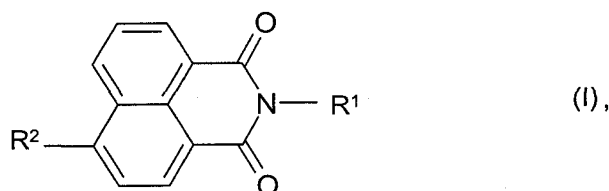
An ethanolic solution of vitamin A ($c=10^{-5}$ mol/l) was exposed in a cuvette to a xenon lamp. PET plaques from Examples 24-26 were placed in the beam path of the xenon lamp. During irradiation, the remaining concentration of vitamin A was measured from its absorbance at 323 nm. Fig. 1 shows the filter effect of the compounds I used in accordance with the invention, as a graph. Since the emissions spectrum of a xenon lamp is similar to that of the sun, Fig. 1 forcefully demonstrates the filter effect of the naphthalene-1,8-dicarboxylic monoimides I used in accordance with the invention. Without the protection of naphthalene-1,8-dicarboxylic monoimides I a vitamin A solution is rapidly broken down by light. In contrast, there is only slight breakdown of the vitamin A solution under the effect of light if the vitamin A solution is protected by a naphthalene-1,8-dicarboxylic monoimide I used in accordance with the invention.

10

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Claims

1. The use of naphthalene-1,8-dicarboxylic monoimides of the formula I



in which

R¹ is hydrogen, alkyl, alkenyl, cycloalkyl, cycloalkenyl, heterocycloalkyl, aryl or heteroaryl and

R² is a radical containing at least one π electron system containing a carbon atom and at least one further atom selected from carbon, oxygen, and nitrogen, with the proviso that the radical contains at least one atom other than carbon

to protect organic material from the damaging effects of light.

2. The use as claimed in claim 1, wherein

R¹ is C₁-C₃₀ alkyl whose carbon chain may be interrupted by one or more non-adjacent groups selected from -O-, -S-, -NR³-, -CO- and/or -SO₂-, and/or which is unsubstituted or substituted one or more times by identical or different radicals selected from cyano, amino, hydroxyl, carboxyl, aryl, heterocycloalkyl, and heteroaryl, with aryl, heterocycloalkyl, and heteroaryl groups being unsubstituted or carrying one or more substituents selected independently of one another from C₁-C₁₈ alkyl and C₁-C₆ alkoxy; or R¹ is C₅-C₈ cycloalkyl which is unsubstituted or carries one or more C₁-C₆ alkyl groups; or

R¹ is 5- to 8-membered heterocycloalkyl which is unsubstituted or carries one or more C₁-C₆ alkyl groups; or

R¹ is aryl or heteroaryl, with aryl or heteroaryl being unsubstituted or carrying one or more radicals selected independently of one another from C₁-C₁₈ alkyl, C₁-C₆ alkoxy, cyano, CONR⁴R⁴ᵃ, CO₂R⁴, arylazo, and heteroarylazo, with arylazo and heteroarylazo in turn being unsubstituted or carrying one or more radicals selected independently of one another from C₁-C₁₈ alkyl, C₁-C₆ alkoxy, and cyano;

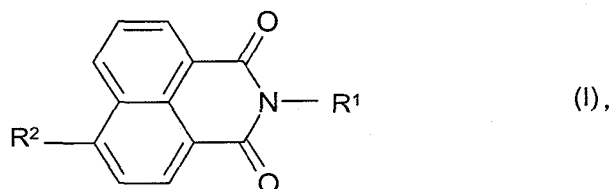
R³ is hydrogen or C₁-C₆ alkyl; and

R⁴ and R⁴ᵃ each independently are hydrogen, C₁-C₁₈ alkyl, aryl or heteroaryl, with aryl and heteroaryl in each case being unsubstituted or carrying one or more substituents selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, hydroxyl, car-

boxyl and cyano.

3. The use as claimed in claim 2, wherein R^1 is C_1 - C_{12} alkyl, C_5 - C_8 cycloalkyl or phenyl, the two last-mentioned radicals each being unsubstituted or carrying one, two, three, four or five C_1 - C_4 alkyl groups.
4. The use as claimed in claim 3, wherein R^1 is phenyl which is unsubstituted or carries one, two or three C_1 - C_4 alkyl groups.
5. The use as claimed in one of the previous claims, wherein R^2 is cyano, $-C(O)NR^5R^{5a}$ or phenyloxy which carries one or more substituents selected from C_1 - C_{12} alkyl, C_1 - C_{12} alkoxy, $-COOR^6$, $-SO_3R^6$, halogen, hydroxyl, carboxyl, cyano, $-CONR^5R^{5a}$, and $-NHCOR^5$; R^5 and R^{5a} each independently of one another are hydrogen, C_1 - C_{18} alkyl, aryl or heteroaryl, aryl and heteroaryl each being unsubstituted or carrying one or more substituents selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, hydroxyl, carboxyl, and cyano; and R^6 is hydrogen or C_1 - C_6 alkyl.
6. The use as claimed in claim 5, wherein R^2 is cyano.
7. The use as claimed in claim 5, wherein R^2 is $-C(O)NH_2$.
8. The use as claimed in claim 5, wherein R^2 is phenyloxy which carries one C_1 - C_{10} alkyl group.
9. The use as claimed in one of the previous claims for stabilizing inanimate organic material.
10. The use as claimed in one of the preceding claims, wherein the material for protection is selected from plastics, polymer dispersions, paints, photographic emulsions, photographic layers, human or animal skin, human or animal hair, cosmetic products, pharmaceutical products, cleaning products, and foodstuffs.
11. The use as claimed in claim 10 to stabilize plastics.
12. The use as claimed in claim 11, wherein the plastic comprises at least one polymer selected from polyesters, polycarbonates, polystyrene, copolymers of styrene or of α -methylstyrene with dienes and/or acrylic derivatives, polyurethanes, polyvinyl acetals, polyolefins, polyacrylates, and polymer blends of the aforementioned polymers, and the reaction products stated when at least two of said polymers are intimately mixed.

13. The use as in one of claims 1 to 8 for preparing a layer which absorbs ultraviolet light.
14. The use as claimed in claim 13, wherein the layer is composed of a thermoplastic molding compound.
15. The use as claimed in claim 14, wherein the thermoplastic molding compound comprises at least one polymer selected from polyesters, polycarbonates, polyolefins, polyvinyl acetals, polystyrene, copolymers of styrene or of α -methylstyrene with dienes and/or acrylic derivatives, and polymer blends of the aforementioned polymers, and the reaction products stated when at least two of said polymers are intimately mixed.
16. The use as claimed in one of the previous claims, wherein at least one compound I is used in an amount of from 0.01 to 10% by weight, based on the weight of the inanimate organic material.
17. The use as claimed in one of the previous claims together with at least one further light stabilizer which has at least one absorption maximum in the wavelength range from 280 to 320 nm.
18. The use as claimed in one of the previous claims as sole light stabilizer from the group of naphthalene derivatives with at least one absorption maximum in the wavelength range above 320 to 400 nm.
19. Compounds of the formula I



in which

- 30 R^1 is hydrogen, alkyl, alkenyl, cycloalkyl, cycloalkenyl, heterocycloalkyl, aryl or heteroaryl; and
- R^2 is cyano, $-C(O)NR^5R^{5a}$ or phenyloxy which carries one, two, three, four or five C_1 - C_{12} alkyl groups; and
- 35 R^5 and R^{5a} each independently of one another are hydrogen, C_1 - C_{18} alkyl, aryl or heteroaryl, aryl and heteroaryl each being unsubstituted or carrying one or more substituents selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, hydroxyl, carboxyl, and cyano.

20. Compounds of the formula I as claimed in claim 18, wherein

R¹ is C₁-C₁₂ alkyl, C₅-C₈ cycloalkyl or phenyl, the last two mentioned radicals each being unsubstituted or carrying one, two, three, four or five C₁-C₄ alkyl groups.

There follows one sheet of drawings

Fig. 1

